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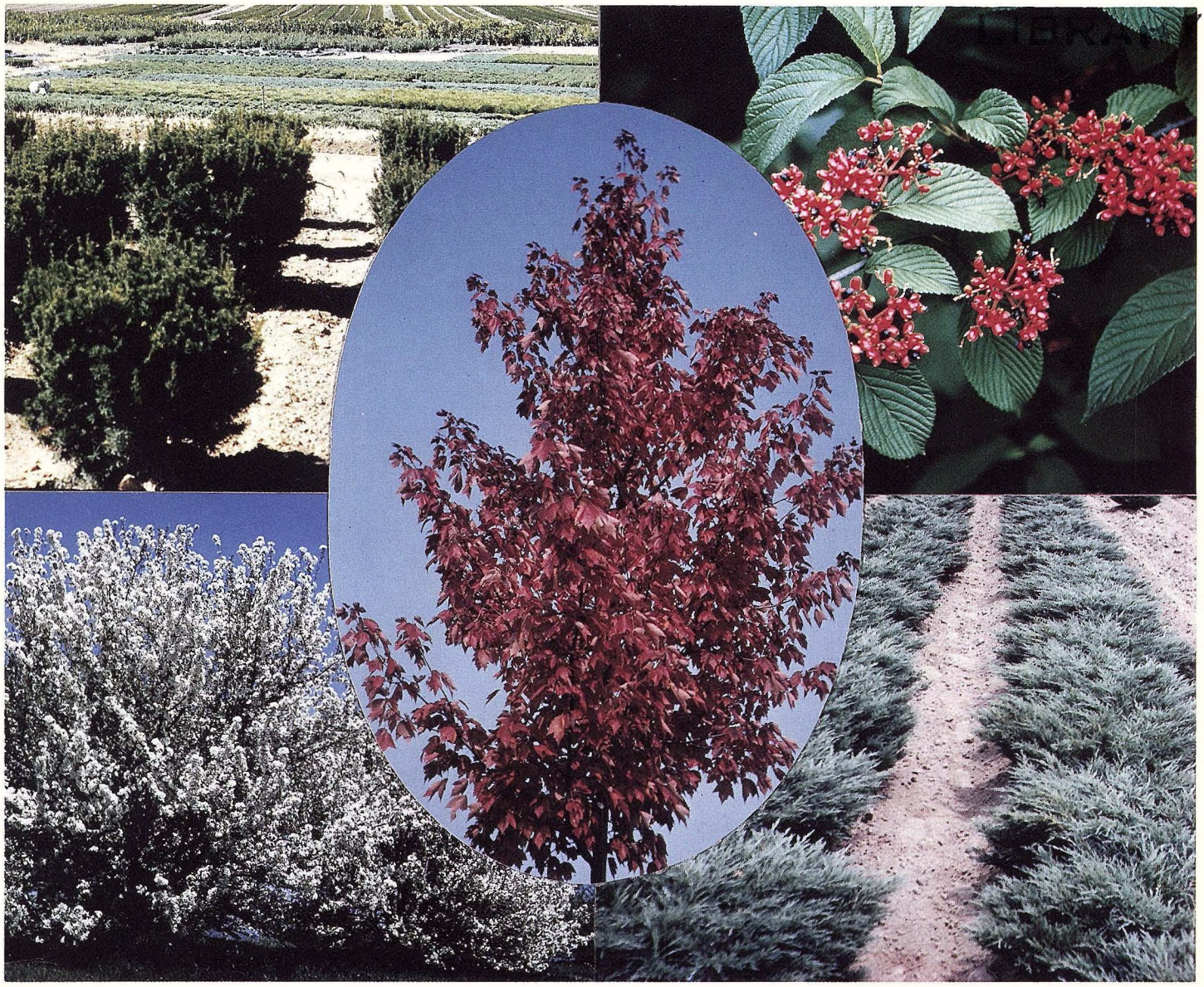
Costs of Establishing and Operating Field Nurseries Differentiated by Size of Firm and Species of Plant in USDA Plant Hardiness Zones 5 and 6

REED D. TAYLOR, HAROLD H. KNEEN, ELTON M. SMITH,
DAVID E. HAHN, and STANLEY UCHIDA



The Ohio State University
Ohio Agricultural Research and Development Center
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ON THE COVER: The five groups of field-grown nursery plants studied in this project: center—shade trees *(Acer rubrum);* clockwise from upper left—slow-growing evergreens *(Taxus),* deciduous shrubs *(Viburnum),* rapid-growing evergreens *(Juniperus),* and ornamental trees *(Malus).*

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PREFACE

This report is one in a series of Southern Cooperative bulletins. Under the cooperative publication procedure, it becomes in effect a separate publication for each of the cooperating stations. It is suggested that copies be requested from one source only. Requests from outside the cooperating states should be addressed to the publishing station, Mailing Room, Ohio Agricultural Research and Development Center, Wooster, OH 44691-6900.

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Members of the manuscript subcommittee for the S–103 regional research project technical committee included: James L. Green of Oregon, chairman; George L. Good, New York; and Travis D. Phillips, Mississippi.

State Experiment Station personnel contributing to this report included: David J. Williams, Illinois; Travis D. Phillips, Mississippi, Reed D. Taylor, Elton M. Smith, and David E. Hahn, Ohio; David J. Beattie, Pennsylvania; and M. B. Badenhop, Tennessee.

ABSTRACT

The objective of this study was to identify the resources and costs associated with two model field nurseries differentiated by size. For each of the two nursery sizes, production systems representative of five groups of field-grown nursery plants differentiated by cultural requirements were delineated. One plant species from each of the five delineated systems was chosen as representative of the group for specific production analysis.

Total production costs per salable "B & B" plant by representative species in the 50-acre nursery were $17.47 for slow-growing evergreens *(Taxus),* $12.51 for rapid growing evergreens *(Juniperus),* $12.00 for deciduous shrubs *(Viburnum),* $54.58 for shade trees *(Acer rubrum),* and $36.82 for ornamental trees *(Malus),* with $20.34 as average of all species. For the 200-acre nursery, comparable figures were $9.39 for slow-growing evergreens *(Taxus),* $7.09 for rapid growing evergreens *(Juniperus),* $7.07 for deciduous shrubs *(Viburnum),* $35.61 for shade trees *(Acer rubrum),* and $24.73 for ornamental trees *(Malus),* with $12.43 as average of all groups.

Fixed costs for all plant groups accounted for a greater proportion of total costs in the 50-acre nursery than in the 200-acre nursery, averaging 55% in the small nursery and 39% in the large. This is attributed to more efficient use of buildings, machinery, and equipment in the large nursery. Based on the technology budgeted, it would take a nursery of at least 200 acres to use the modern facilities and equipment in an economically efficient manner.

Cost differences among species were caused primarily by space requirements, length of the production cycle, cost of liners, and harvest labor requirements. Calculations were based on 1985 prices.

Agricultural Experiment Stations of
Alabama, Arkansas, Florida, Georgia, Illinois, Kentucky,
Louisiana, Mississippi, Missouri, New York, North Carolina, Ohio,
Oregon, Pennsylvania, and Tennessee, in addition to TVA and USDA, cooperating

Costs of Establishing and Operating Field Nurseries Differentiated by Size of Firm and Species of Plant in USDA Plant Hardiness Zones 5 and 6

REED D. TAYLOR, HAROLD H. KNEEN, ELTON M. SMITH, DAVID E. HAHN, and STANLEY UCHIDA[1]

INTRODUCTION

To make more informed decisions as to whether to enter, leave, or expand field production, nurserymen require production, marketing, and financial information. In this bulletin, cost models for production of crops representing five categories of field-grown production schemes and two sizes of nurseries in USDA Plant Hardiness Zones 5 and 6 (Fig. 1) are developed. Physical coefficients are included so the information can be readily updated and so individual nurserymen can use the models as standards against which to compare their own or planned operations. Information derived should provide a basis for decision-making for those evaluating the profitability of establishing a new field nursery, expanding an existing field nursery, or shifting from field production to container production.

Nurserymen throughout the United States have been gradually shifting from field to container production for many species of plants (12). Large companies and many individual nurserymen who traditionally have produced field-grown stock have diversified operations by shifting part of their production to container-grown plants. Containers allow greater flexibility in production and marketing, and at least in some cases, are less expensive than field production (12). On the other hand, risk is reduced when plants are grown in the field. Field-grown plants have greater buffering against variations in moisture, nutrients, and temperature. When subjected to conditions which would kill or severely damage container-grown plants with no overwintering protection, field-grown plants will often survive with little damage. It is also easier to "hold over" field-grown plants when market conditions are not favorable. Field production continues to account for the majority of plants grown for the landscape. However, changes and competition in the industry make it imperative that nurserymen continually and systematically determine production costs.

Production cost models have recently been developed for several species of plants in the Southern and North Central regions of the U.S. (2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14). Most of these models, while providing excellent information for individual species, did not attempt to develop comprehensive models for complete nursery operations. Taylor, *et al.* developed a comprehensive model applicable to Plant Hardiness Zone 6 for container-grown crops representing five categories of container-grown production schemes and two sizes of nurseries (14). Badenhop and Phillips (2) developed a similar study for field-grown crops in USDA Plant Hardiness Zones 7 and 8 representing five categories of field-grown production schemes and two sizes of nurseries. Procedures and data developed by the two earlier comprehensive studies have proved useful and complementary to this study.

OBJECTIVES

The general objective of this study was to develop the resources and costs associated with two model nurseries differentiated by size, including the delineation of representative field production systems. Specific objectives were to:

- Model a series of production systems which would accommodate a majority of the plant species being field-grown in USDA Plant Hardiness Zones 5 and 6.
- Analyze the important species of plants commonly grown in the field in USDA Plant Hardiness Zones 5 and 6, and assign each species to one of five designated groups based on similarities of growing and production requirements.
- Choose one species from each of the five groups as representative of that group for detailed cost analysis.
- Design physical facilities including land areas, land improvements, irrigation systems, buildings, and machine and equipment components for two sizes of commercial field nurseries based on the model production systems.

MATERIALS AND METHODS

In the study, two model firms were synthesized using the conceptual framework of economic engineering wherein the "best proven practice" was included in each model. They were synthesized based on the North Central region. If specific items were required (*i.e.*, depth of the well), coefficients were based on the Columbus, Ohio, area. The complete model included developing an appropriate production cycle; schematic drawings of the physical layout, including buildings and irrigation system; lists of equipment and other items; a complete se-

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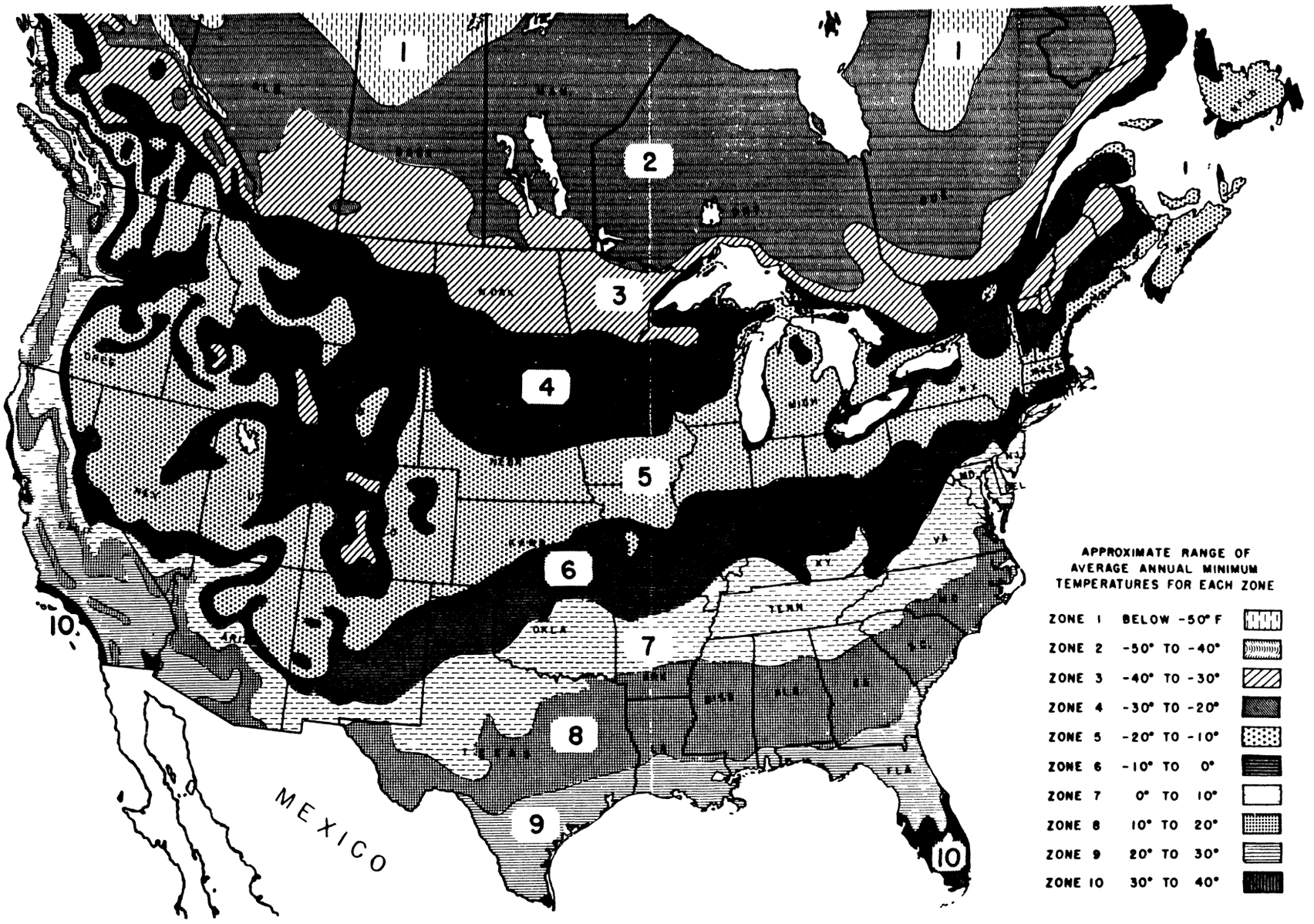


FIG. 1.--USDA Plant Hardiness Zones.

quence by month and year of nursery operational steps beginning with land preparation and ending with loading the finished product for wholesale distribution; and budgets for fixed and variable costs (12).

Data for this study were obtained from wholesale nurseries and nursery suppliers in the North Central region during the late autumn and winter of 1984 and the spring of 1985. Price quotations obtained were for the 1985 production season. The basic goals in synthesizing the production facilities (Figs. 2-5) were to minimize labor expenses, flow and movement of plant material and equipment, maximize the number of salable plants, and allow future expansion.

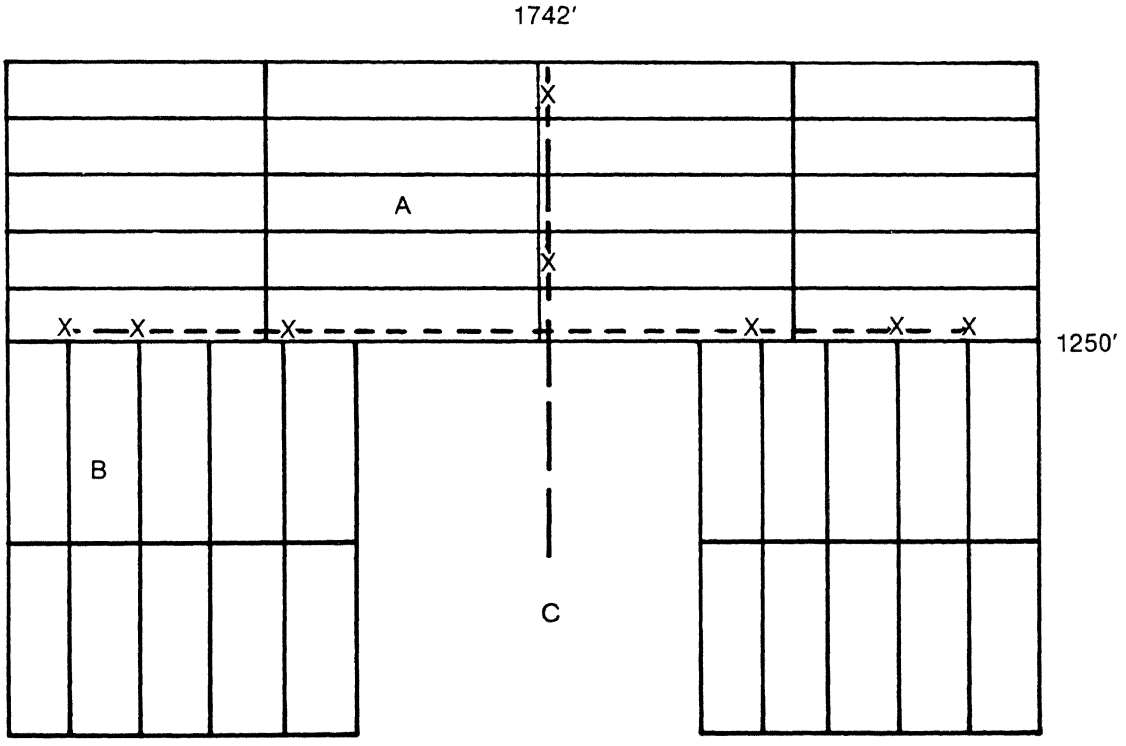
The model small nursery was 50 acres, with 40 acres of growing space and 10 acres of production facilities, holding area, field bed area, and roads. The large nursery was 200 acres, with 175 acres of growing space and 25 acres of production facilities, holding area, field bed area, and roads. Initial analysis for the small nursery showed that basic equipment needed for a modern small nursery could support a much larger operation. It was ascertained that it would take a field nursery of at least 200 acres to use modern facilities and equipment in an economically efficient manner.

Physical Plant and Equipment

Assumptions

Assumptions about the physical facilities and equipment can greatly affect its cost and thereby the cost per salable plant. All items a nursery would typically require were included; thus, the physical plant is probably more elaborate than that of many nurseries. A nurserymar can easily eliminate or reduce items as required. However, it would require substantial effort to do the analysis on his own if they were not included.

Both model nurseries were designed (Figs. 2-5) for future expansion. For example, the 50-acre nursery has a centrally located shipping and "order building" area for four semitractor loads of plant material surrounded



A. Growing plots (20) 100' x 435.6' (1 acre)
B. Growing plots (20) 116.2' x 375' (1 acre)
C. Production facilities, holding area, and field-bed area, 580' x 750'

X. Denotes placement of water hydrants for irrigation

6" PVC pipe - - - - - -

8" PVC pipe —— —— ——

FIG. 2.--Schematic Drawing of 50-Acre Field Nursery, USDA Plant Hardiness Zones 5 and 6.

by growing area (Figs. 2 and 3). Thus, expansion can occur with a minimum of disruption. If growing space was greatly expanded (to 200 acres), the central area could be easily expanded without affecting "permanent" facilities. Specific components for both sizes of nurseries are itemized in Tables 1 and 1a.

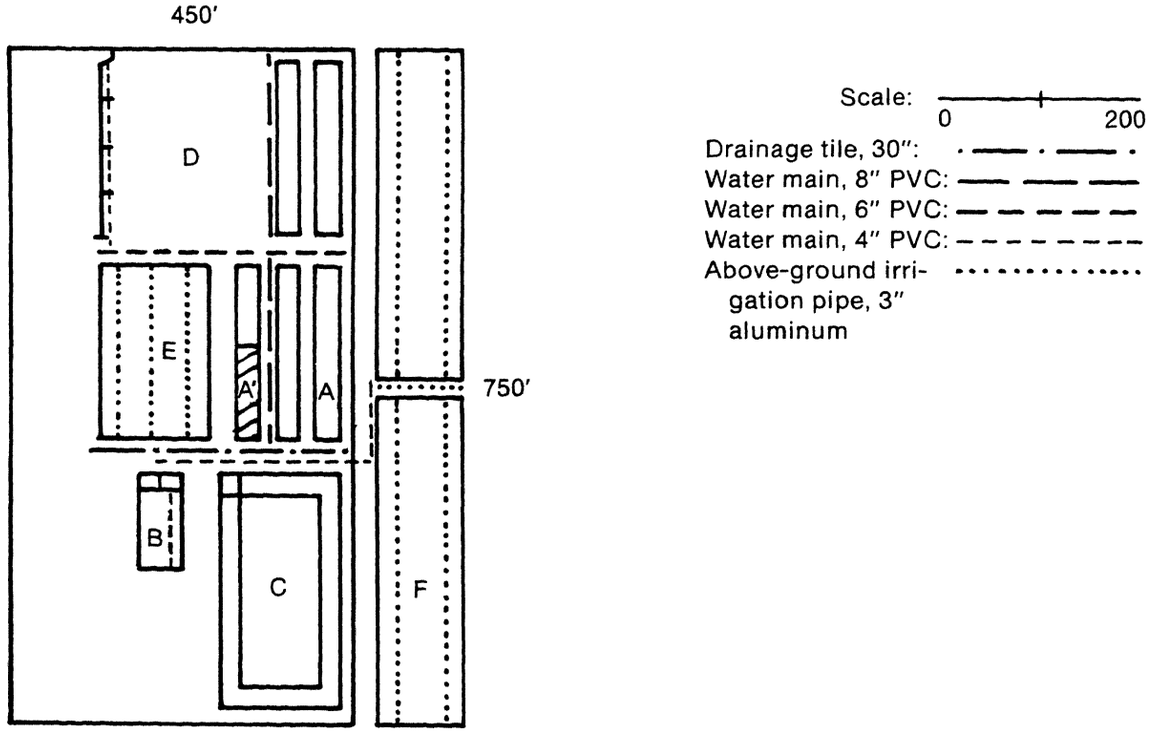
The same buildings, and to a lesser degree, machinery and equipment needed for the 50-acre nursery are also satisfactory for the 200-acre one. Most of the machinery and equipment, even in the large nursery, is under-used but must be available when needed.

Some specific assumptions which add substantially to a "stripped down" facility are as follows:

Self-sufficiency. It was assumed that each model nursery would be self-sufficient except for tree "lining-out" stock. Full costs of required facilities and equipment were assigned to the model nurseries in this study. These costs would have been lower if it was assumed that the facilities and equipment were shared with other enterprises. For example, many field nurseries would also have container-grown plants, with buildings, machinery, and equipment being shared between operations.

Site. Land modification costs could be reduced if the nursery were located on gravelly or sandy soil with good natural drainage. Locating near an open water source could reduce or eliminate the need for a well.

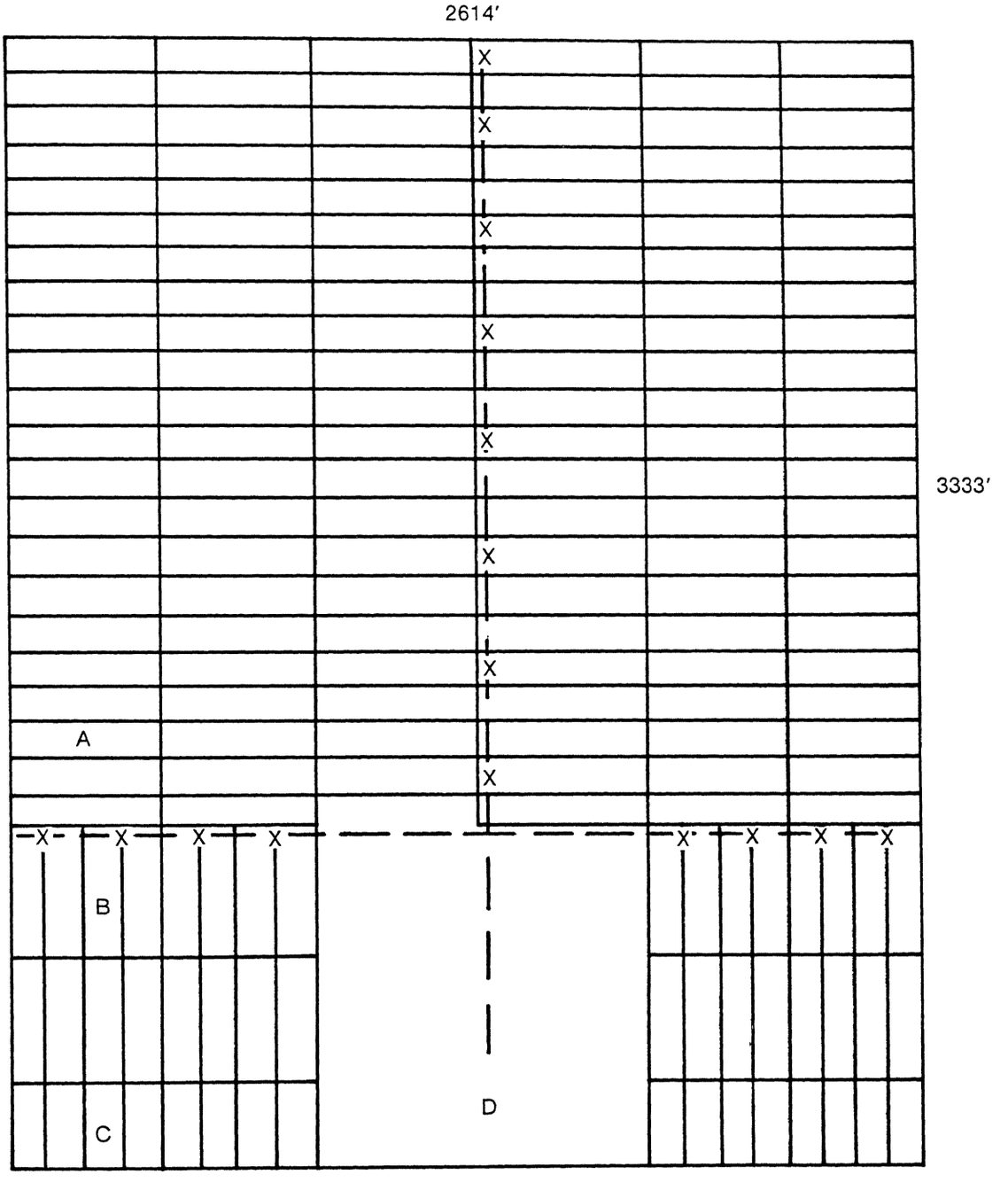
Expansion. Provision was made for expansion, especially for the 50-acre nursery. It became obvious very quickly in the analysis that basic buildings, machinery, and equipment needed for effective operation of the 50-acre nursery were adequate for a much larger system. To provide for expansion, a larger irrigation pump, larger well casing diameter, larger in-ground water



A. Polyhouse structures, 4-1/2 each (20' x 200') = 18,000 sq ft = 0.41 acre
A'. Propagation house, 1/2 each (20' x 200') = 2,000 sq ft = 0.05 acre
B. Supply shed, machinery storage, machine shop (40' x 100')
Office and restrooms (20' x 40')
C. Pond (80' x 220' x 14' depth), pump house (10' x 10')
D. Shipping area (100' x 200')
E. Holding area (100' x 200') = 20,000 sq ft = 0.46 acre.
F. Liner bed area, 2 each (125' x 330') = 82,500 sq ft = 1.89 acres

Total acreage, 450' x 750' = 337,500 sq ft = 7.75 acres

FIG. 3.--Schematic Drawing of 50-Acre Field Nursery's Production Facilities, Holding Area, and Field-Bed Area, USDA Plant Hardiness Zones 5 and 6. (Detail of Area C of Figure 2.)



A. Growing plots (131) 100.0' x 435.6' (1 acre)
B. Growing plots (32) 108.9' x 400.0' (1 acre)
C. Growing plots (16) 108.9' x 300.0' (3/4 acre)
D. Production facilities, holding area, and field-bed area, 870' x 1200' (Note: 1 acre from this area was used as a growing plot.)

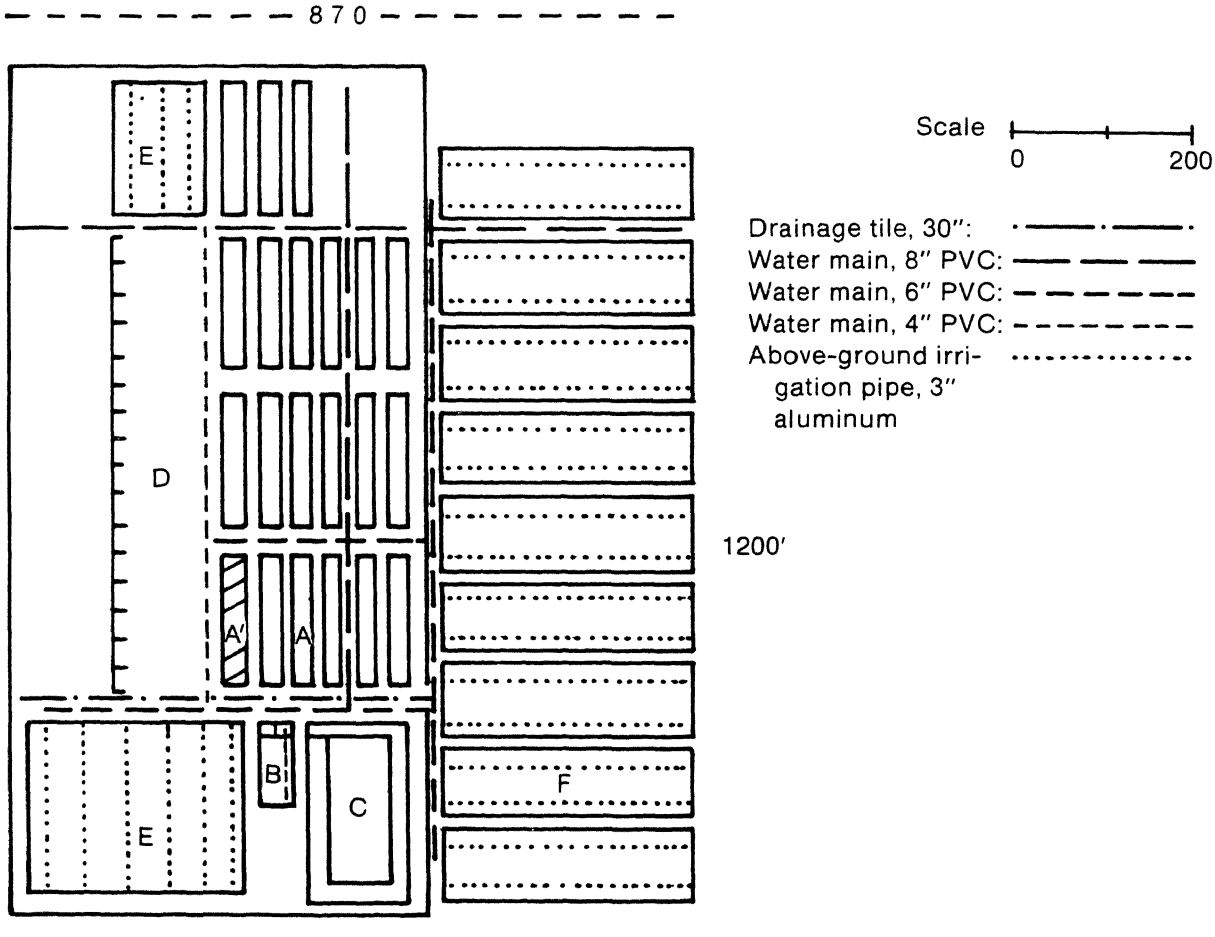
X. Denotes placement of water hydrants for irrigation

8" PVC pipe — — —

FIG. 4.--Schematic Drawing of 200-Acre Field Nursery, USDA Plant Hardiness Zones 5 and 6.

mains, and a more powerful traveler irrigation gun were provided than might have been necessary for the 50-acre nursery if expansion was not contemplated. The 50-acre nursery, as engineered, could be expanded to at least 200 acres with little addition of facilities or equipment. While expansion was also provided for the larger nursery, it was much less than for the small. It was felt that if the 200-acre nursery was to get much larger, it would start running into other "limiting factors" much faster than in the case of the 50-acre nursery. Different expandability factors for the two sizes of nurseries build some bias into the analysis favoring the 200-acre nursery when comparing costs per salable plant between the two sizes.

Machinery and Equipment. Purchase of new machinery and equipment was assumed for the model nurseries to achieve true replacement costs. Many nurserymen, however, may choose to buy used equipment, rent equipment, or time-share some expensive items with other nurseries.



A. Polyhouse structure, 20 each (20' x 200') = 80,000 sq ft = 1.84 acres
A'. Propagation house, 1 each (20' x 200') = 4,000 sq ft = .09 acre
B. Supply shed, machinery storage, machine shop (40' x 100')
Office and restrooms (20' x 40')
C. Pond (80' x 220' x 14' depth), pump house (10' x 10')
D. Shipping area (10 semitruck loads)
E. Holding area (240' x 280') and (200' x 64') = 80,000 sq ft = 1.84 acres
F. Liner bed area, 9 each (100' x 330') = 297,000 sq ft = 6.82 acres

Total acreage, 870' x 1200' = 1,044,000 sq ft = 23.97 acres

Fig. 5.--Schematic Drawing of 200-Acre Field Nursery's Production Facilities, Holding Area, and Field-Bed Area, USDA Plant Hardiness Zones 5 and 6. (Detail of Area D of Figure 4.)

TABLE 1.—Capital Requirements for a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description†	Unit	Useful Life (yr)	Quantity	Cost per Unit ($)	Total Cost ($)	Percent of Total Cost
Land	Unimproved land	acre		50	2 000	100,000	16
+Improvements	Grading tiling graveling pond		20			115,156	19
Subtotal						215,156	35
Buildings							
Office and restrooms	20' x 40	sq ft	20	800	35	28,000	5
Plant and supply storage	40 x 50	sq ft	20	2 000	20	40,000	6
Machinery storage and shop	40 x 50	sq ft	20	2 000	20	40,000	7
Polyhouse structures	200' x 20'	each	10	5	2 761	13,805	2
Subtotal						121,805	20
Machinery and Equipment							
Tractor, 100 hp	100 hp, diesel fuel	each	10	1	28,278	28,278	5
Tractor, 34 hp	34 hp, gas fuel	each	10	2	14,504	29,008	5
Articulated 4-wheel drive loader	Swinger 320—lift capacity = 3,000 lb	each	10	1	38,000	38,000	6
Tree spade	530P handles 20", 22", and 24" + lift pads	each	2	1	8,490	8,490	1
Forks	For front-end loaders	each	10	1	1 100	1,100	‡
Plow	3-14 inch plows	each	10	1	2,616	2,616	‡
Disk	8' wide	each	10	1	3,900	3,900	1
Harrow	10' wide	each	10	1	650	650	‡
Cultimulcher—bed area	10' wide	each	10	1	3,800	3,800	1
Sprayrig (boom sprayer)	100" gallon tank with 7' and 10' booms	each	7	1	1,407	1,407	‡
Transplanter, 3-row	3-20" row bed transplanter	each	10	1	7,500	7,500	1
Transplanter, 1-row	Tree planter	each	10	1	5,000	5,000	1
Permanent irrigation/well pump	100 hp electric pump	each	20	1	36,396	36,396	6
In-ground irrigation/bed area	PVC pipe/valves		20		11,064	11,064	2
Above-ground irrigation/bed area	Aluminum pipe/valves/sprinkler heads		5		1,829	1,829	‡
In-ground irrigation storage/holding	PVC pipe/valves		20		6,904	6,904	1
Above-ground irrigation storage/holding	Aluminum pipe/valves/sprinkler heads		5		2,405	2,405	‡
Traveler gun—field irrigation	450-500 gallons per minute		10	1	22,000	22,000	4
Portable irrigation pump (emergency)	40 hp P T O irrigation pump/foot valve	each	10	1	425	425	‡
Airblast sprayer	Myer—300 gallon high pressure on trailer	each	7	1	3,600	3,600	1
Fertilizer injector	26-gallon injector—bed use	each	5	2	858	1,716	‡
Transplanter, 2-row	2-42/48" row field transplanter	each	10	1	5,600	5,600	1
U-Blade—field	18" for undercutting	each	5	1	240	240	‡
Undercutter—bed	Bed undercutter, 50" blade, lift tines	each	7	1	285	285	‡
Fertilizer sidedresser	2-row sidedresser	each	10	1	1,000	1,000	‡
Cultivator, 2 row	2-row field cultivator	each	7	1	1,700	1,700	‡
Wagon	4-wheel, farm wagon	each	10	4	1,978	7,912	1
Cultivator, 3-row	3-row bed cultivator	each	7	1	2,250	2,250	‡
Truck	1/2-ton pickup truck	each	5	1	13,485	13,485	2
Pallets	Wooden	each	2	181	12	2,172	‡
Hand tools	Miscellaneous	sets	5	20	100	2,000	‡
Seeder	Broadcast seeder		10	1	175	175	‡
Mower	7'—3-blade mower		10	1	2,283	2,283	‡
Flatbed truck**	24' flatbed, gas fuel		5	1/2	42,000	21,000	3
Heating system for progagation							
Gas-fired unit heater—Modine	200,000 BTU (input)	each	10	1	1,104	1,104	‡
Fan jet	Acme	each	10	1	103	103	‡
Thermostat	Two-stage	each	10	1	44	44	‡
Set-up for propane**	Ventilator, regulator, etc.	each	10	1	100	100	‡
Set-up for heating system	Plywood, braces, bolts, etc.	each	10	1	100	100	‡
Other propagation materials							
Misting system	Mist-a-matic	each	2	3	249	747	‡
Pipe and nozzles	For misting system		2	1	300	300	‡
Treated boards	5/4" x 8" x variable length	foot	2	330	0 74	244	‡
Heating cable	Propagation	foot	2	900	0 35	315	‡
Subtotal						279,247	45
TOTAL						616,208	100

*Total nursery = 50 acres, with 40 acres of growing space and 10 acres in production facilities, holding and field bed area, roads, etc.

†For details on individual items, see the following tables: land improvements—Table 2; polyhouse construction—Table 3, overall irrigation system-Table 4; irrigation for winter storage and holding area—Table 4a, irrigation for bed and field—Table 4b, well and electric pump—Table 4c.

‡Less than one-half of 1%.

**One-half the cost of a flatbed truck was budgeted for the small nursery's field production.

††Propane tanks, connectors, etc. will be leased from the company supplying propane.

TABLE 1a.—Capital Requirements for a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description†	Unit	Useful Life (yr)	Quantity	Cost per Unit ($)	Total Cost ($)	Percent of Total Cost
Land	Unimproved land	acre	- -	200	2,000	400,000	29
+Improvements	Grading, tiling, graveling, pond		20			284,210	21
Subtotal						684,210	50
Buildings							
Office and restrooms	20' x 40'	sq ft	20	800	35	28,000	2
Plant and supply storage	40' x 50'	sq ft	20	2,000	20	40,000	3
Machinery storage and shop	40' x 50'	sq ft	20	2,000	20	40,000	3
Polyhouse structures	200' x 20'	each	10	21	2,761	57,981	4
Subtotal						165,981	12
Machinery and Equipment							
Tractor, 100 hp	100 hp, diesel fuel	each	10	1	28,278	28,278	2
Tractor, 60 hp	60 hp diesel fuel	each	10	1	20,419	20,419	1
Tractor, 34 hp	34 hp, gas fuel	each	10	4	14,504	58,016	4
Articulated 4-wheel drive loader	Swinger 220—lift capacity = 2,000 lb	each	10	2	25,000	50,000	4
Articulated 4-wheel drive loader	Swinger 320—lift capacity = 3,000 lb	each	10	2	38,000	76,000	6
Tree spade	530P handles 20", 22", and 24" + lift pads	each	2	2	8,490	16,980	1
Forks	For front-end loaders	each	10	4	1,100	4,400	‡
Plow	3-14" plows	each	10	1	2,616	2,616	‡
Disk	8' wide	each	10	1	3,900	3,900	‡
Harrow	10' wide	each	10	1	650	650	‡
Cultimulcher—bed area	10' wide	each	10	1	3,800	3,800	‡
Sprayrig (boom sprayer)	100-gallon tank with 7' and 10' booms	each	7	1	1,407	1,407	‡
Transplanter, 3-row	3-20" row bed transplanter	each	10	1	7,500	7,500	1
Transplanter, 1-row	Tree planter	each	10	1	5,000	5,000	‡
Permanent irrigation/well pump	100 hp electric pump	each	20	1	36,396	36,396	3
In-ground irrigation/bed area	PVC pipe/valves		20		34,606	34,606	3
Above-ground irrigation/bed area	Aluminum pipe/valves/sprinkler heads		5		4,347	4,347	‡
In-ground irrigation storage/holding	PVC pipe/valves		20		17,959	17,959	1
Above-ground irrigation storage/holding	Aluminum pipe/valves/sprinkler heads		5		8,286	8,286	1
Traveler gun—field irrigation	450-500 gallons per minute		10	1	22,000	22,000	2
Portable irrigation pump	40 hp P.T.O. irrigation pump/foot valve	each	10	1	425	425	‡
Airblast sprayer	Myer—300 gallon high pressure on trailer	each	7	1	3,600	3,600	‡
Fertilizer injector	26-gallon injector	each	5	2	858	1,716	‡
Transplanter, 2-row	2-42/48" row field transplanter	each	10	1	5,600	5,600	‡
U-Blade—field	18" for undercutting	each	5	1	240	240	‡
Undercutter—bed	Bed undercutter, 50" blade, lift tines	each	7	1	285	285	‡
Fertilizer sidedresser	2-row sidedresser	each	10	1	1,000	1,000	‡
Cultivator, 2-row	2-row field cultivator	each	7	2	1,750	3,500	‡
Wagon	4-wheel, farm wagon	each	10	8	1,978	15,824	1
Cultivator, 3-row	3-row bed cultivator	each	7	1	2,250	2,250	‡
Truck	1/2-ton pickup truck	each	5	2	13,485	26,970	2
Pallets	Wooden	each	2	482	12	5,784	‡
Hand tools	Miscellaneous	sets	5	76	100	7,600	1
Seeder	Broadcast seeder		10	1	175	175	‡
Mower	7'—3-blade mower		10	1	2,283	2,283	‡
Flatbed truck**	24' flatbed, gas fuel		5	1	42,000	42,000	3
Heating system for progagation							
Gas-fired unit heater—Modine	200,000 BTU (input)	each	10	2	1,104	2,208	‡
Fan jet	Acme	each	10	2	103	206	‡
Thermostat	Two-stage	each	10	2	44	88	‡
Set-up for propane**	Ventilator, regulator, etc.	each	10	2	100	200	‡
Set-up for heating system	Plywood, braces, bolts, etc.	each	10	2	100	200	‡
Other propagation materials							
Misting system	Mist-a-matic	each	2	6	249	1,494	‡
Pipe and nozzles	For misting system		2	2	300	600	‡
Treated boards	5/4" x 8" x variable length	foot	2	1,320	0.74	977	‡
Heating cable	Propagation	foot	2	3,600	0.35	1,260	‡
Subtotal						529.045	38
TOTAL							

*Total nursery = 200 acres, with 175 acres of growing space and 25 acres in production facilities, holding and field bed area, roads, etc.

†For details on individual items, see the following tables: land improvements—Table 2; polyhouse construction—Table 3; overall irrigation system—Table 4; irrigation for winter storage and holding area—Table 4a; irrigation for bed and field—Table 4b; well and electric pump—Table 4c.

‡Less than one-half of 1%.

**Propane tanks, connectors, etc. will be leased from the company supplying propane.

Components

Land Improvement. For full utilization of the production facilities, holding area, and field-bed area, extensive grading, graveling, surface and underground drainage tiles were provided (Table 2). This area was graded to allow a gradual slope from a high point at the shipping area to lower points on the edges. In addition, every two rows of polyhouses were sloped toward each other to utilize a common buried 30-inch drain tile which drains to the grassy waterways at the perimeter of the central area. Liner bed areas and general field production were tiled with 4-inch plastic tile, 30 feet on center, 46 inches deep using a herringbone design.

Due to irrigation needs and rainfall, the problem of ground erosion occurs. Even with low application rates, the need to allow for base soil saturation and the possibility of heavy natural rainfall necessitates graveling storage and shipping areas. For any area that heavy equipment may run over (roadways, shipping area, and machine storage shed), #4 gravel was used. In other graveled areas, a finer #8 grade was utilized. Although the cost of this graveling operation is high, it is offset by greater efficiencies and dependability in the handling of plants, ability to reenter the areas after natural or artificial irrigation, and reduction of soil erosion.

A pond was included even though it was assumed a well could be dug with sufficient regenerative water capacity. This was done to reduce the risk to plants while in holding areas in case of disruptions caused by repairs or electrical failure. An auxiliary take-off drive from the pump could be powered by a 100-HP tractor for temporary irrigation. The pond also would function as a dis-

TABLE 2.—Land Improvement Costs for 50- and 200-Acre Field Nurseries, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Unit	Cost per Unit ($)	50-Acre Field Nursery* Quantity (units)	50-Acre Field Nursery* Total Cost ($)	200-Acre Field Nursery† Quantity (units)	200-Acre Field Nursery† Total Cost ($)
Grading						
Grading of land and pond top soil removal, 410 0 cu yd per acre @ $2 00 per cu yd	acre	820‡	5 60	4,592	13.64	11,185
Grading including cutting and filling, 900 cu yd per acre @ $1 75 per cu yd	acre	1,575	5 60	8,820	13 64	21,483
Grading for pond				22,815		22,815
Subtotal				36,227		55,483
Tiling (Water Drainage)						
Central production facilities 30" cement pipe @ $16 59/ft, installation labor @ $11 41/ft	ft	28	900 00	25,200	1,450 00	40,600
Bed area 4" plastic tile, 30' on center, herringbone design, 42" depth	acre	750	1 89	1,418	6 82	5,115
Field area 4" plastic tile, 30' on center, herringbone design, 42" depth	acre	750	42 25	31,688	176.00	132,000
Subtotal				58,306		177,715
Graveling						
Production area within polyhouse structures, 20' x 200', 3" depth of #8 gravel = 37.04 cu yd per polyhouse or 37.04 ton @ $7.80/ton delivered and spread	polyhouse	7 80	185 20	1,445	778 00	6,068
Area between polyhouse structures, 4" depth of #4 gravel = 49 38 cu yd or 49.38 ton per 20' x 200' section @ $7.80/ton delivered and spread	20' x 200' section	7.80	148 14	1,155	629.68	4,912
Production area excluding grass, growing areas, pond—4" depth of #4 gravel = 532.4 cu yd or 532.4 ton per acre @ $7.80/ton delivered and spread	acre	4,152.72	4 34	18,023	9.64	40,032
Subtotal				20,623		51,012
TOTAL				115,156		284,210

*50 acres total; 7.75 acres of production facilities, holding and field-bed area.
†200 acres total; 23.97 acres of production facilities, holding and field-bed area.
‡Soil removed for grading was not sold; rather it was placed in the field area.

charge site when operating the pump at higher efficiency levels than needed for immediate irrigation purposes.

Buildings. Each nursery was assumed to require similar sizes of permanent buildings for the receiving of nursery stock/storage (50′ x 40′), machinery repair/storage (50′ x 40′), office space (20′ x 20′), and restroom facilities (20′ x 20′).

Propagation Facilities. For propagating the three classes of shrubs, the 50-acre nursery was provided with one-half of a 20′ x 200′ polyhouse and the 200-acre nursery a full 20′ x 200′ polyhouse. These propagation areas are equipped with double polyethylene covers and heating equipment.

Overwintering Facilities. Polyhouses were provided to overwinter one-fourth of a year's shrub harvest. Four and one-half (20′ x 200′) polyhouses are provided for the 50-acre nursery and 20 are provided for the 200-acre nursery. These structures, larger than the traditional 14′ x 96′, allow easier access and use of machinery, especially for "balled and burlapped" material. Cost per square foot is essentially the same as for smaller structures.

Irrigation System. Irrigation systems were designed to minimize labor efforts and plant loss risk, yet provide sufficient irrigation capabilities to meet present and future water needs even under the most unlikely situations. A basic irrigation system is composed of four parts: water source, pumping equipment, inground irrigation pipe, and above ground irrigation pipe and materials (Tables 4-4c).

The water source must have adequate reserves to meet maximum water needs and sufficient purity to meet cultural requirements. Because municipal water is expensive, especially if the production site is located far from a center of population, a well in conjunction with a constructed lake or a site situated near an open water source would be desirable. The open water source would have to be chosen with care. Most open water sources have problems due to collection of water from many sources. Shallow water sources have algae problems requiring

TABLE 3.—Cost of Polyhouse Construction for 50- and 200-Acre Field Nurseries, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Cost per Item ($)	Number of Items per Polyhouse	Cost per Polyhouse ($)	50-Acre Field Nursery* Number of Polyhouses	50-Acre Field Nursery* Total Cost ($)	200-Acre Field Nursery† Number of Polyhouses	200-Acre Field Nursery† Total Cost ($)
Polyhouse Framework—20′ x 200′							
Galvanized steel pipe arches, 3/4″ x 32′ lengths @ $0.57 ft	18.24	51 ea	930	5	4,650	21	19,530
Ground inserts, 1″ x 4.2′ @ $0 75 ft	315	102 ea	321	5	1,605	21	6,741
Threaded ridge line, 3/4″ x 200′ @ $0.57 ft	114.00	1 ea	114	5	570	21	2,394
End braces, 3/4″ x 32′ @ $0.57 ft	18.24	4 ea	73	5	365	21	1,533
Subtotal			1,438		7,190		30,198
Hardware							
Bolts for connecting arches and ground inserts, 3″ x 3/4″	0.12	102 ea	12	5	60	21	252
Hinges, 3″ rustproof	1.20	12 ea	14	5	70	21	294
Door latch, hasp	4.00	2 ea	8	5	40	21	168
Subtotal			34		170		714
Wood—Treated White Pine							
1 1/4″ x 8″ x roughcut 3 graded or better	0.74	440 ft	326	5	1,630	21	6,846
2″ x 4″ x 8′ rough	3.31	4 ea	13	5	65	21	273
2″ x 4″ x 12′ rough	4.96	4 ea	20	5	100	21	420
1″ x 6″ x 8′ rough	2.60	4 ea	10	5	50	21	210
1″ x 6″ x 12′ rough	3.95	4 ea	16	5	80	21	336
2″ x 2″ x 8′ finished	2.14	5 ea	11	5	55	21	231
Subtotal			396		1,980		8,316
Labor Requirements	6.93‡	100 hr	693	5	3,465	21	14,553
Miscellaneous			200	5	1,000	21	4,200
TOTAL			2,761**		13,805		57,981

*50 acres total; 20,000 sq ft of polyhouse space.
†200 acres total; 84,000 sq ft of polyhouse space.
‡Average basic wage before withholding taxes and fringe benefits $5.25; taxes and fringe benefits add 32% or $1.68 for a total of $6.93.
**Approximately $0.69 per square foot.

special filters. Also, present/future demands made by industries downstream or upstream may adversely affect flow rates and chemical composition of the water. Construction requirements for a pond or lake would include sufficient holding capacity to meet potential water demands and an adequate water supply furnished either by watershed areas, tappable underground water, springs, or some other source. The models in this study assumed an adequate water source found approximately 60 feet below ground. The well was dug to a depth of 80 feet to ensure adequate recharging capacity. In some areas of USDA Plant Hardiness Zones 5 and 6, wells would have to be drilled to much greater depths which would result in higher costs.

To properly develop a comprehensive irrigation system, the following must be considered: water pressure requirements of the sprinkler heads and the traveler gun, water pressure loss due to pipe and valve friction, area to be irrigated at one time, and potential future expansion.

Selection of a well pump is crucial to the nursery operation. As a basic guideline, the maximum pressure loss from entrance point to the farthest point of irrigation within a lateral should be less than 20% of the pounds per square inch (psi) reading as found at the pump. This assures a constant rate of application from all sprinkler heads on the line. The second guideline is that the combined amount of water exiting the sprinklers and/or traveler gun used at one irrigation setting must be less than the total flow of water coming from the pump. A 100-HP electric pump was selected to drive the water from an 80-foot deep well (Table 4c). It takes a 100-HP pump to supply enough pressure to drive the traveler gun discharging 450-500 gallons per minute. The well depth depends not only on the depth at which water is found but also on the amount of water being drawn per minute by the pump. An electric motor was chosen because of reliability of performance, low maintenance cost, and close availability of three-phase electrical power.

In addition, the following were provided for protection: a simple housing unit to enclose the pump, a branch in the foot valve attachment for pumping from the adjacent above ground auxiliary water source, and a right angled gear drive added to the pump in case of a power outage. Using the provided equipment, a tractor can power the pump to provide water into the pond and in a separate operation move water from the pond through the irrigation system.

The third part of the irrigation system is the inground irrigation pipe. The advantages of inground water mains are: labor costs for pipe movement are eliminated, breakage due to equipment running over above

TABLE 4.—Costs of Irrigation Systems for 50- and 200-Acre Field Nurseries, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	50-Acre Field Nursery* Total Cost ($)	200-Acre Field Nursery† Total Cost ($)
Winter Storage and Holding Area‡		
In-ground irrigation system	6,904	17,959
Above-ground irrigation system		
Polyhouse structures	1,072	4,101
Holding area	1,333	4,185
Subtotal (winter storage and holding area)	9,309	26,245
Field/Bed Irrigation**		
In-ground irrigation system	11,064	34,606
Above-ground irrigation system	1,829	4,345
Traveler gun	22,000	22,000
Subtotal (field/bed irrigation)	34,893	60,951
TOTAL (not including well and pump)	44,202	87,196
Cost of Well††	13,500	13,500
Cost of Pump††	22,896	22,896
Total for Irrigation System	80,598	123,592

*50 acres total.
†200 acres total.
‡For details, see Table 4a.
**For details, see Table 4b.
††For details, see Table 4c.

TABLE 4c.—Specifications and Costs of Installing a 100 hp Electric Well Pump and an 80-Foot Well, USDA Plant Hardiness Zones 5 and 6, 1985.

Specifications	Total Cost ($)
Pump—above ground, 100 hp* lineshaft, 1,800 rpm	
Basic electric motor	4,087
Discharge head, 8"	1,196
Standard 10' length, column, 80' depth assembly 8" x 1-1/2"	4,325
Suction pipe, 8" x 10'	340
Pump bowl assembly—3-stage, 12" pump	2,688
Air line gauge and air line	45
Well seal, well plate, cement	350
Electrical equipment	88
Installation fee	1,000
Right angle gear drive, auxiliary power source using a tractor	2,986
Subtotal	17,105
+ Freight @ 10%	1,791
+ Building	4,000
Total cost for pump, including shelter	22,896
Well Drilling	
Casting diameter, 14" O D	13,500
Total cost for well	13,500
TOTAL	36,396

*A 100 hp pump can supply 900 gallons of water per minute at 65 psi given the specifications and site location

ground pipe is eliminated, and lower initial cost of P.V.C. pipe compared to portable above ground aluminum. The inground system would be installed below the frost line (between 4 and 5 feet deep). As shown in Figs. 2-5, 8-inch P.V.C. pipe forms major laterals.

The fourth part of the irrigation system would be above ground and would include frost-free hydrants. Three-inch, portable, latchless, aluminum pipe was provided for irrigation within the central area. Rotating #30BH rainbird sprinklers were provided for dispersing water in the central area. A traveler gun with a dispersion rate of 450-500 gallons per minute was provided for irrigating the growing-out areas.

Soil Conservation. Minimal soil conservation is provided. After the last plants are harvested in a field, the field is left fallow until the following spring. Fallow fields are disked for weed control four times during summer months and then plowed in the fall in preparation for spring planting. A more intense conservation program might consist of summer green manure crops plowed under such as alfalfa or sudan; rye grasses/fescue grown between rows of trees; and grass grown in waterways and on the surface of access roads. Leaving the fields planted in a cover crop for 2 years might be desirable in some cases.

Nurserymen interested in a soil conservation program should contact agents of the Soil Conservation Service located nearest to their nursery for assistance in designing a sound conservation plan which would include good cultural practices. The costs of implementing a program would have to be identified and included as a part of the annual costs of operating the nursery. These costs would have to be captured in the costs of producing a salable plant.

TABLE 4a.—Costs of Irrigation Systems for the Winter Storage and Holding Areas for 50- and 200-Acre Field Nurseries, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Unit	Cost per Unit ($)	50-Acre Field Nursery* Quantity Needed	50-Acre Field Nursery* Total Cost ($)	200-Acre Field Nursery† Quantity Needed	200-Acre Field Nursery† Total Cost ($)
In-ground Irrigation System						
8" pipe, PVC	ft	3 98	506	2,014	1,656	6,591
6" pipe PVC	ft	2 34	640	1,498	1 089	2,548
4" pipe, PVC	ft	1 24	379	470	1,114	1,381
2" pipe, PVC	ft	0 46	36	17	124	57
Additional required equipment, estimated at 20% of pipe value				800		2,116
Installation charges						
for 6" and 8" pipe	ft	1 35	1,146	1 547	2,745	3 706
for 2" and 4" pipe	ft	1 26	443	558	1,238	1,560
Subtotal				6,904		17,959
Above-ground Irrigation System						
1 Polyhouse structures—storage 1-frost-free hydrant 1" @ $60 00 200 ft of 1" PVC pipe @ $0 22/ft = $44 00 Installation labor/parts, estimated at 30% of pipe cost = $13 20 10-rotating sprinklers, Nelson Whizhead 5/64" nozzles @ $4 95 = $49 50	polyhouse	166 70	5	1,072‡	21	4,101‡
2 Holding area						
3" pipe, latchless aluminum	ft	1 57	600	942	2,080	3,266
Additional fittings 20% of pipe cost				188		208
Pipe riser 3/4" diameter x 48"	ea	5 30	10	53	35	186
Rotating sprinkler, #30BH Rainbird, nozzle size 5/32" x 3/32"	ea	15 00	10	150	35	525
Subtotal (above-ground irrigation system for storage and holding area)				2,405		8,286
TOTAL				9,309		26,245

*50 acres total
†200 acres total
‡Cost includes extra frost-free hydrants used in other areas

TABLE 4b.—Costs of Bed and Field Irrigation for 50- and 200-Acre Field Nurseries, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Unit	Cost per Unit ($)	50-Acre Field Nursery* Quantity Needed	50-Acre Field Nursery* Total Cost ($)	200-Acre Field Nursery† Quantity Needed	200-Acre Field Nursery† Total Cost ($)
Field/Bed Irrigation						
In ground irrigation system						
8 pipe PVC mainline pipe	ft	3 98	450	1 791	4 372	17 401
6 pipe PVC mainline pipe	ft	2 24	1 659	3 716	1 008	2 359
4 pipe PVC upright pipe	ft	1 24	4	5	64	79
Hydrant	ea	180 00	8	1 440	16	2 880
Additional required equipment estimated at 20% of pipe and hydrant value				1 330		4 544
Installation charges						
for 6 and 8 pipe	ft	1 35	2 056	2 777	5 380	7 263
for 4 pipe	ft	1 26	4	5	64	80
Subtotal (in-ground irrigation system)				11 064		34 606
Above-ground irrigation system						
3 pipe aluminum portable latchless	ft	1 57	820	1 287	1 940	3 046
Additional required equipment estimated at 20% of pipe value				258		609
Sprinkler risers 3/4 x 48	ea	5 30	14	74	34	180
Rotating sprinkler #30BH Rainbird nozzle size 5/32 x 3/32	ea	15	14	210	34	510
Subtotal (above-ground irrigation system)				1 829		4,345
Traveler gun 450-500 gpm	ea	22 000	1	22 000	1	22 000
Total Bed and Field Irrigation				34 893		60,951

*50 acres total
†200 acres total

Enterprise Mix

It was assumed that the two model nurseries would produce a diverse line of nursery stock. The length of the production cycle for the different species grown will vary. Commonly grown nursery stock was divided into five cultural groups. While not all-inclusive, the groups permit a range of per unit costs to be developed as they relate to input costs and cultural factors. For analytical purposes, it was assumed that each cultural group would occupy 20% of the nursery area (*i.e.*, 50-acre nursery = 8 acres production plus 2 acres facility per group; 200-acre nursery = 35 acres production plus 5 acres facility per group). Annual sales capacity for the 50-acre nursery would be 20,759 plants and for the 200-acre nursery 90,867 plants. For detailed analysis, one specific plant from each group was chosen as representative of the group. While it is recognized that other plants from each category would have somewhat different requirements, it was felt that the requirements would not vary significantly in cost from the representative plant. The five groups (plant types chosen for detailed analysis are designated with a star) with some of their cultural characteristics are listed below.

Group	Plant	Cultural Characteristics
I	Slow-Growing Evergreens	
	**Taxus* (species)	18-24" salable plant
	Buxus (species)	12" B&B
		10.2 sq ft of growing space per plant
II	Rapid-Growing Evergreens	
	**Juniperus chinensis* (varieties)	18-24" salable plant
	horizontalis (varieties)	12" B&B
		10.2 sq ft of growing space per plant
	Pinus strobus	
	Thuja (species)	
III	Deciduous Shrubs	
	**Viburnum* (species)	3-4' salable plant
	Forsythia (species)	12" B&B
	Weigela (species)	11.9 sq ft of growing space per plant
	Ligustrum (species)	
IV	Shade Trees	
	**Acer rubrum* (varieties)	2" caliper
	Acer platanoides (varieties)	24" B&B
		33.6 sq ft of growing space per plant
	Fraxinus (species)	
	Quercus (species)	
	Tilia (species)	
	Gleditsia (species)	
V	Ornamental Trees	
	**Malus* (flowering crab) (species)	5-6' (1-1/2 to 1-3/4" caliper)
	Prunus (ornamental plums) (species)	20" B&B
		28.7 sq ft per plant

TABLE 5.—Annual Fixed Costs ($) for a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Depreciation†	Interest‡	Insurance and Taxes**	Total
Land	Unimproved land	- -	12,000	2,000	14,000
+Improvements	Grading, tiling, graveling, pond	5,182	13,819	2,303	21,304
Subtotal		5,182	25,819	4,303	35,304
Buildings					
Office and restrooms	20′ x 40′	1,260	3,360	685	5,305
Plant and supply storage	40′ x 50′	1,800	4,800	978	7,578
Machinery storage and shop	40′ x 50′	1,800	4,800	978	7,578
Polyhouse structures (5 ea)	200′ x 20′	1,242	1,657	338	3,237
Subtotal		6,102	14,617	2,979	23,698
Machinery and Equipment					
Tractor, 100 hp	100 hp, diesel fuel	2,545	3,393	107	6,045
Tractor, 34 hp (2 ea)	34 hp, gas fuel	2,611	3,481	110	6,202
Articulated 4-wheel drive loader	Swinger 320—lift capacity = 3,000 lb.	3,420	4,560	144	8,124
Tree spade	530P handles 20″, 22″, and 24″ + lift pads	3,821	1,019	32	4,872
Forks	For front-end loaders	99	132	4	235
Plow	3-14″ plows	235	314	10	559
Disk	8′ wide	351	468	15	834
Harrow	10′ wide	59	78	2	139
Cultimulcher—bed area	10′ wide	342	456	14	812
Sprayrig (boom sprayer)	100-gallon tank with 10′ boom	181	169	5	355
Transplanter, 3-row	3-20″ row bed transplanter	675	900	28	1,603
Transplanter, 1-row	Tree planter	450	600	19	1,069
Permanent irrigation/well pump	100 hp electric pump	1,638	4,368	138	6,144
In-ground irrigation/bed area	PVC pipe/valves	498	1,328	42	1,868
Above-ground irrigation/bed area	Aluminum pipe/valves/sprinkler heads	329	220	7	556
In-ground irrigation storage/holding	PVC pipe/valves	311	829	26	1,166
Above-ground irrigation storage/holding	Aluminum pipe/valves/sprinkler heads	433	289	9	731
Traveler gun—field irrigation	450-500 gallons per minute	1,980	2,640	83	4,703
Portable irrigation pump	40 hp P.T.O irrigation pump/foot valve	38	51	2	91
Airblast sprayer	300 gallon high pressure on trailer	463	432	14	909
Fertilizer injector (2 ea)	26-gallon injector—bed use	309	206	6	521
Transplanter, 2-row	2-42″ row field transplanter	504	672	21	1,197
U-Blade—field	18″ for undercutting	43	29	1	73
Undercutter—bed	Bed undercutter, 50″ blade, lift tines	37	34	1	72
Fertilizer sidedresser	2-row sidedresser	90	120	4	214
Cultivator, 2-row	2-row field cultivator	219	204	6	429
Wagons (4 ea)	4-wheel, farm wagon	712	949	30	1,691
Cultivator, 3-row	3-row bed cultivator	289	270	9	568
Truck	1/2 ton pickup truck	2,427	1,618	51	4,096
Pallets (181 ea)	Wooden	977	261	8	1,246
Hand tools (20 sets)	Miscellaneous	360	240	8	608
Seeder	Broadcast seeder	16	21	1	38
Mower	7′—3-blade mower	205	274	9	488
Flatbed truck (1/2 unit)	24′ flatbed, gas fuel	3,780	2,520	79	6,379
Heating system for propagation					
Gas-fired unit heater—Modine	200,000 BTU (input)	99	132	4	235
Fan jet	Acme	10	12	††	22
Thermostat	Two-stage	4	5	††	9
Set-up for propane	Ventilator, regulator, etc.	9	12	††	21
Set-up for heating system	Plywood, braces, bolts, etc.	9	12	††	21

*Total of 50 acres, with 40 acres in growing space and 10 acres in production facilities, holding area, field bed area, roads, etc.

†Depreciation was estimated by dividing initial cost (adjusted for a 10% salvage value) by the years of useful life.

‡Interest costs were estimated by multiplying the initial value of land, buildings, equipment, and machinery by the interest rate, 12% per annum.

**Insurance and taxes.

Land and improvements—only taxes are assessed, at a rate of $20 per $1,000 of market value.

Buildings—taxes assessed at a rate of $20 per $1,000 of market value. Insurance, $500 deductible, at $4.46 per $1,000 of market value. Total for category = $24.46 per $1,000.

Machinery and equipment—taxes are not assessed in Ohio on personal property. Insurance, $500 deductible, at $3.78 per $1,000 of initial value.

††Less than $0.50.

‡‡Insurance for personnel was estimated at 32% of salaries for owner/operator, supervisor, and clerical.

***Owner/operator = $30,000, supervisor = $20,000, clerical = $10,000, supplies 10% or $6,000. Total = $66,000.

TABLE 5 (continued).—Annual Fixed Costs ($) for a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Depreciation†	Interest‡	Insurance and Taxes**	Total
Machinery and Equipment (continued)					
Other propagation materials					
Misting systems (3 ea)	Mist-a-matic	336	90	3	429
Pipe and nozzles	For misting systems	135	36	1	172
Treated boards	5/4" x 8" x variable length	110	29	1	140
Heating cable		141	38	1	180
Subtotal		31,300	33,511	1,055	65,866
Total for Depreciation, Interest, Insurance, and Taxes		42.584	73,947	8,337	124,868
General Overhead					
Utilities	Telephone, electric, gas heat				6,200
Licenses and bonds					400
General repairs and maintenance	Buildings, grounds, roads				7,060
Advertising and printing					1,200
Insurance, personnel‡‡	Workmen's compensation, FICA, health, unemployment				19,200
Travel and professional fees					1,900
Administrative and management***	Clerical, operator, supervisory, labor, and office supplies				66,000
Miscellaneous					1,000
Subtotal					102,960
Interest on General Overhead, Insurance and Taxes	12% per annum for 6 months on a total of $111,297				6,678
Total Annual Fixed Costs					234,506

*Total of 50 acres, with 40 acres in growing space and 10 acres in production facilities, holding area, field bed area, roads, etc.
†Depreciation was estimated by dividing initial cost (adjusted for a 10% salvage value) by the years of useful life.
‡Interest costs were estimated by multiplying the initial value of land, buildings, equipment, and machinery by the interest rate, 12% per annum.
**Insurance and taxes.
Land and improvements—only taxes are assessed, at a rate of $20 per $1,000 of market value.
Buildings—taxes assessed at a rate of $20 per $1,000 of market value. Insurance, $500 deductible, at $4.46 per $1,000 of market value. Total for category = $24.46 per $1,000.
Machinery and equipment—taxes are not assessed in Ohio on personal property. Insurance, $500 deductible, at $3.78 per $1,000 of initial value.
††Less than $0.50.
‡‡Insurance for personnel was estimated at 32% of salaries for owner/operator, supervisor, and clerical.
***Owner/operator = $30,000, supervisor = $20,000, clerical = $10,000, supplies 10% or $6,000. Total = $66,000.

Production Cost Budgets

Costs were established for all factors of production including management and invested capital. In economic terms, costs associated with factors of production inputted by owner/operators are often referred to as 'opportunity costs' or the income these factors could have received if they were employed elsewhere. For example, owners could usually be employed as managers at other nurseries, and money invested in land, buildings, irrigation systems, and equipment could have earned interest if it had been placed in financial institutions.

Capital requirements for establishing the nurseries were first determined (Tables 1 and 1a). Second, the physical factors associated with the 50-acre and 200-acre nurseries and annual shipment requirements were established (Tables 6, 6a, 6b, 6c, and 7). Third, production systems for the enterprises budgeted were described (Appendices A–F). Fourth, annual fixed costs were calculated (Tables 5 and 5a). Fifth, estimated variable costs for each of the five groupings of plants for the 50-acre and 200-acre nurseries were determined (Tables 8–12a). Sixth, summaries were made of fixed and variable costs for each plant group at each size of nursery (Tables 14 and 15). This allowed cost comparisons based on cultural group and size of nursery.

Most nurseries use cash rather than accrual accounting procedures. For this reason, the analyses were completed on a "cash" basis. Analyses on a "cash" basis do not give a true economic picture of the cost of producing a plant as they do not take into account the time value of money from the time the plant is planted until it is harvested. The analyses do, however, give a true estimate of the annual cost per salable plant. Another problem with cash accounting is taking into account the start-up period (*i.e.*, the period from when costs are first

TABLE 5a.—Annual Fixed Costs ($) for a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Depreciation†	Interest‡	Insurance and Taxes**	Total
Land	Unimproved land	- -	48,000	8,000	56,000
+Improvements	Grading, tiling, graveling, pond	12,789	34,105	5,684	52,578
Subtotal		12,789	82,105	13,684	108,578
Buildings					
Office and restrooms	20′ x 40′	1,260	3,360	685	5,305
Plant and supply storage	40′ x 50′	1,800	4,800	978	7,578
Machinery storage and shop	40′ x 50′	1,800	4,800	978	7,578
Polyhouse structures (21 ea)	200′ x 20′	5,218	6,958	1,418	13,594
Subtotal		10,078	19,918	4,059	34,055
Machinery and Equipment					
Tractor, 100 hp	100 hp, diesel fuel	2,545	3,393	107	6,045
Tractor, 60 hp	60 hp, diesel fuel	1,838	2,450	77	4,365
Tractor, 34 hp (4 ea)	34 hp, gas fuel	5,221	6,962	219	12,402
Articulated 4-wheel drive loader (2 ea)	Swinger 220—lift capacity = 2,000 lb.	4,500	6,000	189	10,689
Articulated 4-wheel drive loader (2 ea)	Swinger 320—lift capacity = 3,000 lb	6,840	9,120	287	16,247
Tree spade (2 ea)	530P handles 20″, 22″, and 24″ + lift pads	7,641	2,038	64	9,743
Forks	For front-end loaders	396	528	17	941
Plow	3-14″ plows	235	314	10	559
Disk	8′ wide	351	468	15	834
Harrow	10′ wide	59	78	2	139
Cultimulcher—bed area	10′ wide	342	456	14	812
Sprayrig (boom sprayer)	100-gallon tank with 10′ boom	181	169	5	355
Transplanter, 3-row	3-20″ row bed transplanter	675	900	28	1,603
Transplanter, 1-row	Tree planter	450	600	19	1,069
Permanent irrigation/well pump	100 hp electric pump	1,638	4,367	138	6,143
In-ground irrigation/bed area	PVC pipe/valves	1,557	4,153	131	5,841
Above-ground irrigation/bed area	Aluminum pipe/valves/sprinkler heads	782	522	16	1,320
In-ground irrigation storage/holding	PVC pipe/valves	808	2,155	68	3,031
Above-ground irrigation storage/holding	Aluminum pipe/valves/sprinkler heads	1,491	994	31	2,516
Traveler gun—field irrigation	450-500 gallons per minute	1,980	2,640	83	4,703
Portable irrigation pump	40 hp P.T.O irrigation pump/foot valve	38	51	2	91
Airblast sprayer	300 gallon high pressure on trailer	463	432	14	909
Fertilizer injector (2 ea)	26-gallon injector	307	205	6	518
Transplanter, 2-row	2-42″ row field transplanter	504	672	21	1,197
U-Blade—field	18″ for undercutting	43	29	1	73
Undercutter—bed	Bed undercutter, 50″ blade, lift tines	37	34	1	72
Fertilizer sidedresser	2-row sidedresser	90	120	4	214
Cultivator, 2-row (2 ea)	2-row field cultivator	450	420	13	883
Wagons (8 ea)	4-wheel, farm wagon	1,424	1,899	60	3,383
Cultivator, 3-row	3-row bed cultivator	289	270	9	568
Truck (2 ea)	1/2 ton pickup truck	4,855	3,236	102	8,193
Pallets (482 ea)	Wooden	2,603	694	22	3,319
Hand tools (76 sets)	Miscellaneous	1,368	912	29	2,309
Seeder	Broadcast seeder	16	21	1	38
Mower	7′—3-blade mower	205	274	9	488
Flatbed truck**	24′ flatbed, gas fuel	7,560	5,040	159	12,759
Heating system for propagation					
Gas-fired unit heaters (2 ea)	200,000 BTU (input)	199	265	8	472
Fan jet (2 ea)	Acme	19	24	1	44
Thermostat (2 ea)	Two-stage	8	11	††	19
Set-up for propane (2 ea)	Ventilator, regulator, etc.	18	24	1	43
Set-up for heating system (2 ea)	Plywood, braces, bolts, etc.	18	24	1	43

*Total of 200 acres, with 175 acres of growing space and 25 acres in production facilities, holding area, field bed area, roads, etc.

†Depreciation was estimated by dividing initial cost (adjusted for a 10% salvage value) by the years of useful life.

‡Interest costs were estimated by multiplying the initial value of land, buildings, equipment, and machinery by the interest rate, 12% per annum.

**Insurance and taxes.

Land and improvements—only taxes are assessed, at a rate of $20 per $1,000 of market value.

Buildings—taxes assessed at a rate of $20 per $1,000 of market value. Insurance, $500 deductible, at $4.46 per $1,000 of market value. Total for category = $24.46 per $1,000.

Machinery and equipment—taxes are not assessed in Ohio on personal property. Insurance, $500 deductible, at $3.78 per $1,000 of initial value.

††Less than $0.50.

‡‡Insurance for personnel was estimated at 32% of salaries for owner/operator, supervisor, and clerical.

***Owner/operator = $35,000, two supervisors @ $20,000 each = $40,000, two clerical @ $10,000 each = $20,000, supplies 10% or $9,500. Total = $104,500.

TABLE 5a. (continued).—Annual Fixed Costs ($) for a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Depreciation†	Interest‡	Insurance and Taxes**	Total
Machinery and Equipment (continued)					
Other propagation materials					
Misting systems (6 ea)	Mist-a-matic	672	179	6	857
Pipe and nozzles	For misting systems	270	72	2	344
Treated boards	5/4" x 8" x variable length	440	117	4	561
Heating cable		567	151	5	723
Subtotal		61,993	63,483	2,001	127,477
Total for Depreciation, Interest, Insurance, and Taxes		84,860	165,506	19,744	270,110
General Overhead					
Utilities	Telephone, electric, gas heat				9,200
Licenses and bonds					600
General repairs and maintenance	Buildings, grounds, roads				12,200
Advertising and printing					1,800
Insurance, personnel‡‡	Workmen's compensation, FICA, health, unemployment				30,400
Travel and professional fees					2,725
Administrative and management***	Clerical, operator, supervisory, labor, and office supplies				104,500
Miscellaneous					2,000
Subtotal					163,425
Interest on General Overhead, Insurance and Taxes	12% per annum for 6 months on a total of $183,169				10,990
Total Annual Fixed Costs					444,525

*Total of 200 acres, with 175 acres of growing space and 25 acres in production facilities, holding area, field bed area, roads, etc
†Depreciation was estimated by dividing initial cost (adjusted for a 10% salvage value) by the years of useful life.
‡Interest costs were estimated by multiplying the initial value of land, buildings, equipment, and machinery by the interest rate, 12% per annum
**Insurance and taxes
Land and improvements—only taxes are assessed, at a rate of $20 per $1,000 of market value.
Buildings—taxes assessed at a rate of $20 per $1,000 of market value. Insurance, $500 deductible, at $4.46 per $1,000 of market value. Total for category = $24.46 per $1,000.
Machinery and equipment—taxes are not assessed in Ohio on personal property. Insurance, $500 deductible, at $3.78 per $1,000 of initial value.
††Less than $0.50.
‡‡Insurance for personnel was estimated at 32% of salaries for owner/operator, supervisors, and clerical.
***Owner/operator = $35,000, two supervisors @ $20,000 each = $40,000, two clerical @ $10,000 each = $20,000, supplies 10% or $9,500. Total = $104,500.

incurred until salable plants are ready). This study did not attempt to assess costs or alternative actions for this period.

Fixed Costs

Annual fixed costs are presented in Tables 5 and 5a. Most of these derived costs were based on the physical plant and equipment discussed previously. These costs were grouped into five categories: 1) land and land improvements; 2) buildings; 3) machinery and equipment; 4) general overhead; and 5) opportunity cost of capital for general overhead, insurance, and taxes. Annual fixed costs for land and land improvements, buildings, and machinery and equipment were composed of depreciation, interest, insurance, and taxes. Depreciation was calculated by dividing initial cost adjusted for salvage value by the years of useful life. Interest costs were estimated by multiplying the initial value of land and land improvements, buildings, machinery, and equipment by 12% per annum. Taxes and insurance costs were based on rates prevailing in the rural areas adjacent to Columbus, Ohio. Land, land improvements, and buildings were assessed taxes at the rate of $20 per $1,000 of market value. Insurance was set at $4.46 per $1,000 of market value for buildings and $3.78 per $1,000 of initial value for equipment. Costs for general overhead were determined on a current basis. Interest charges for general overhead, insurance, and taxes were computed for a 6-month average use period at a rate of 12% per annum.

General Overhead. Cost items not described in detail elsewhere, but which make up a substantial portion of annual fixed costs, are placed here. These costs can be classified as follows: utilities, licenses and bonds, advertising and printing, insurance for personnel, travel and professional fees, administrative and management salaries and supplies, and miscellaneous.

TABLE 6.—Plant Densities and Losses for Field Production of Nursery Plants, USDA Plant Hardiness Zones 5 and 6, 1985.

Group	Description	Size of Salable Plant	Years in Rotation	Spacing Between Rows	Spacing in Rows	Sq Ft per Plant*	Plants per Acre	Estimated Percent Loss†
I	Slow-growing Evergreens—*Taxus*	18-24	7	44	28	10 2	4 272	15
II	Fast-growing Evergreens—*Juniperus*	18-24	5	44	28	10 2	4 272	15
III	Deciduous Shrubs—*Viburnum*	3-4	4	48	30	11 9	3 652	15
IV	Shade Trees—*Acer rubrum*	2 diameter	5	96	42	33 6	1 298	10
V	Ornamental Trees—*Malus*	5-6 (1-1/2)	4	96	36	28 7	1 518	10

*Sq ft per plant includes necessary perimeter roads

†Assume one-half of loss between first and second year and remainder in last year of production Losses in the last year of production would be left in the field

TABLE 6a.—Planting and Harvesting Requirements for a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

		Propagation†	Bedding Area‡	Field Planting			
Plant Group	Description	Units Stuck	Rooted Cuttings Planted	Acres	Acres Planted per Year	Units Planted per Year	Units Harvested** per Year
I	Slow-growing Evergreens—*Taxus*	7,914	6,088	8	1 14	4 870	4,140
II	Fast-growing Evergreens—*Juniperus*	11,107	8,544	8	1 60	6,835	5,810
III	Deciduous Shrubs—*Viburnum*	11,869	9,130	8	2 00	7,304	6,208
IV	Shade Trees—*Acer rubrum*††	--	--	8	1 60	2,076	1,869
V	Ornamental Trees—*Malus*††	--	--	8	2 00	3,036	2,732
	TOTAL	30,890	23,762	40	8 34	24,121	20,759

*Total of 50 acres, with 40 acres in field growing space and 10 acres in production facilities, holding area, field bed area, roads, etc

†For each plant available for transplanting as a rooted cutting into the bedding area, it is estimated that 1 3 cuttings would need to be stuck in the propagation facility

‡For each plant available for transplanting into the field, it is estimated that 1 25 rooted cuttings would need to be planted in the bedding area

**Assume one-half dug in the fall for fall sales and overwintering and one-half dug in the spring

††Shade and ornamental trees would be purchased as bare-root liners for planting directly into the field

TABLE 6b.—Planting and Harvesting Requirements for a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

		Propagation†	Bedding Area‡	Field Planting			
Plant Group	Description	Units Stuck	Rooted Cuttings Planted	Acres	Acres Planted per Year	Units Planted per Year	Units Harvested** per Year
I	Slow-growing Evergreens—*Taxus*	37,710	26,700	35	5.00	21,360	18,156
II	Fast-growing Evergreens—*Juniperus*	48,594	37,380	35	7.00	29,904	25,418
III	Deciduous Shrubs—*Viburnum*	51,927	39,944	35	8.75	31,955	27,162
IV	Shade Trees—*Acer rubrum*††	--	--	35	7.00	9,086	8,177
V	Ornamental Trees—*Malus*††	--	--	35	8.75	13,283	11,954
	TOTAL	138,231	104,024	175	36.50	105,588	90,867

*Total of 200 acres, with 175 acres in field growing space and 25 acres in production facilities, holding area, field bed area, roads, etc.

†For each plant available for transplanting as a rooted cutting into the bedding area, it is estimated that 1.3 cuttings would need to be stuck in the propagation facility.

‡For each plant available for transplanting into the field, it is estimated that 1.25 rooted cuttings would need to be planted in the bedding area.

**Assume one-half dug in the fall for fall sales and overwintering and one-half dug in the spring.

††Shade and ornamental trees would be purchased as bare-root liners for planting directly into the field.

Utilities include heat, electricity, and telephone services to the production department. It does not include fuel for equipment or machinery. Licenses and bonds are made up of expenses for inspection and certification to sell plants. General maintenance and repairs include those expenses of maintaining roads and minor repairs to buildings which cannot be capitalized plus maintenance of grounds such as grass cutting and litter pickup. Advertising and printing involve procurement of letterhead items, nursery signs, employee handbooks, want ads for employment, and nursery price lists. Insurance for personnel includes workmen's compensation, FICA, health insurance, and unemployment insurance for administration and management personnel (hourly laborer costs are included in hourly rates). Travel is made up of expenses to extension workshops, state meetings, and regional meetings. Professional fees include membership costs of national, state, and local nursery associations. Administration and management are made up of salaries or wages of clerical personnel, management and supervisory personnel, miscellaneous insurance, and office supplies. Miscellaneous includes replacement of office equipment not depreciable plus unexpected costs. It should be noted that this item could be significantly reduced if many of the costs, especially administrative and management, were shared with a container operation or some other type of business.

To determine annual fixed costs per cultural group,

TABLE 6c.—Overwintering Requirements* for 50-Acre† and 200-Acre‡ Field Nurseries, USDA Plant Hardiness Zones 5 and 6, 1985.

			50-Acre Field Nursery			200-Acre Field Nursery		
Item	Description	Sq Ft per Plant Required**	No. of Plants Over-wintered	Sq Ft of Polyhouse Required††	Sq Ft of Holding Area Required	No. of Plants Over-wintered	Sq Ft of Polyhouse Required††	Sq Ft of Holding Area Required
I	Slow-growing Evergreens—*Taxus*	4	1,035	4,140	--	4,539	18,156	--
II	Fast-growing Evergreens—*Juniperus*	4	1,453	5,812	--	6,355	25,418	--
III	Deciduous Shrubs—*Viburnum*	4	1,552	6,208	--	6,791	27,164	--
IV	Shade Trees—*Acer rubrum*	15	467	--	7,009	2,044	--	30,660
V	Ornamental Trees—*Malus*	15	683	--	10,245	2,989	--	44,835
	TOTAL		5,190	16,160‡‡	17,254	22,718	70,738‡‡	75,495

*Assumed one-fourth of year's production overwintered.
†Total of 50 acres, with 40 acres of field growing space and 10 acres of production facilities, holding area, field bed area, roads, etc.
‡Total of 200 acres, with 175 acres of field growing space and 25 acres of production facilities, holding area, field bed area, roads, etc.
**Sq ft per plant includes necessary perimeter roads.
††One 20 x 200 sq ft polyhouse can hold 900 plants where each requires 4 sq ft. The center pathway (2' x 200') would take up 400 sq ft of space which would not be available for plants.
‡‡50-acre field nursery would require 4.5 polyhouses, 200-acre field nursery would require 19.7 polyhouses.

TABLE 7.—Shipping Requirements for 50-Acre* and 200-Acre† Field Nurseries, USDA Plant Hardiness Zones 5 and 6, 1985.

				50-Acre Field Nursery		200-Acre Field Nursery	
Plant Group	Description	B & B Size	Units per Truck	Units to be Shipped‡	No. of Truckloads	Units to be Shipped‡	No. of Truckloads
I	Slow-growing Evergreens—*Taxus*	12"	690	4,140	6.0	18,156	26.3
II	Fast-growing Evergreens—*Juniperus*	12"	690	5,810	8.4	25,418	36.8
III	Deciduous Shrubs—*Viburnum*	12"	690	6,208	9.0	27,162	39.4
IV	Shade Trees—*Acer rubrum*	24"	100	1,869	18.7	8,177	81.8
V	Ornamental Trees—*Malus*	18"	140	2,732	19.5	11,954	85.4
	TOTAL			20,759	61.6	90,867	269.7
Trucks Required	Fall				15		67
	Spring—March				11		51
	April				24.6**		100.7**
	May				11		51

*Total of 50 acres, with 40 acres of growing space and 10 acres of production facilities, holding area, field bed area, roads, etc.
†Total of 200 acres, with 175 acres of field growing space and 25 acres of production facilities, holding area, field bed area, roads, etc.
‡One-fourth will be shipped in the fall; three-fourths will be shipped in the spring; one-fourth of the spring shipment in March, one-half in April, and one-fourth in May.
**Limiting factor. In the small nursery it will be necessary to ship 6+ truckloads per week and in the large 25+.

TABLE 8.—Variable Costs (Dollars) for Group I Plants *(Taxus)* for a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Propagation‡					
Rooting media	Sand	cu yd	6 50	9 00	58
Collecting stripping and sticking	7914 units @ 1200/hr	hr	6 93**	6 60	46
Maintenance	50% of total propagation maintenance hr	hr	6 93	365 00	2,530
Harvest	7914 units @ 600/hr	hr	6 93	13 19	91
Hormone powder	#8, I B A	lb	15 50	0 23	4
Subtotal					2,729
Materials					
Burlap	32 x 32" squares + twine	ea	0 45	4,140 00	1,863
Polyethylene film	4 mil white 32' x 225	ea	127 50	1 04	133
Strip tags	5/8' x 7" plastic strip tags	ea	0 02	4,140 00	83
Chemicals	Custom spread, custom blend 45-0-0, 0-44-0, 0-0-60 (fertilizer)	ton	176 00	0 72	127
	Custom spread (lime)	ton	20 00	1 28	26
	Urea, 45-0-0 (fertilizer)	ton	220 00	1 38	304
	Soluble 20-20-20 (fertilizer)	ton	1,411 20	0 14	198
	Trifluralin 4 EC (Treflan) (herbicide)	gallon	33 49	0 32	11
	Simazine 80WP (Princep) (herbicide)	lb	3 75	17 45	65
	DCPA 75WP (Dacthal) (herbicide)	lb	6 37	50 69	323
	Malathion, 57EL (Cythion) (insecticide)	gallon	18 28	16 34	299
	Benomyl 50WP (Benlate) (fungicide)	lb	14 17	10 89	154
	Carbaryl 80WP (Sevin) (insecticide)	lb	6 09	27 23	166
	Chlorothalonil 10M cu ft (Termil) (fungicide)	canister	1 76	3 12	5
	Other (*i e*, Kelthane, Captan, Di-syston, Orthene, etc)††				310
Subtotal					4,067
Machinery and Equipment					
	Tractor, 100 hp	hr	17 00	32 54	553
	Tractor, 34 hp	hr	4 99	32 31	161
	Articulated loader/3,000 lb	hr	14 81	26 98	400
	Forks	hr	0 01	73 24	1
	Plow, 3-14'	hr	6 57	1 02	7
	Disk, 8' wide	hr	4 23	2 09	9
	Harrow, 10 wide	hr	8 45	0 16	1
	Cultimulcher, 10' wide	hr	24 70	0 31	8
	Spray rig with 10' boom	hr	2 77	2 76	8
	Transplanter, 3-row	hr	26 79	1 23	33
	Permanent irrigation/well and pump 100 hp	hr	7 60	86 28	656
	In-ground irrigation — bed/field area	hr	3 13	72 00	225
	Above-ground irrigation — bed area	hr	1 83	72 00	132
	In-ground irrigation — storage and holding	hr	5 65	12 00	68
	Above-ground irrigation — storage and holding	hr	11 05	12 00	133
	Traveler gun	hr	12 06	2 28	28
	Portable PTO pump, 40 hp (emergency)	hr		(no costs budgeted)	
	Airblast sprayer	hr	1 01	21 78	22
	Fertilizer injector	hr	12 39	4 50	56
	Transplanter, 2-row	hr	12 00	2 03	24
	Undercutter, bed	hr	1 16	1 17	1
	U-Blade	hr	17 56	0 38	7

*Total nursery = 50 acres, with 40 acres of growing space and 10 acres in production facilities, holding and field bed area, roads, etc
Group I plants = 10 acres, with 8 acres of growing space and 2 acres in production facilities, holding and field bed area, roads, etc
4,140 18-24" salable plants per year

†Quantity discounts were applied to chemicals and other items

‡7,914 plants would be stuck in the propagation house annually and about 23% would be lost over a 2-year period, leaving 6,088 for transplanting into liner beds About 20% of the plants in the liner beds would be lost over a 3-year period, leaving 4,870 for transplanting into the field

**Average basic wage before withholding taxes and fringe benefits = $5 25, taxes and fringe benefits add 32% or $1 68 for a total of $6 93

††To achieve better pest and disease control, alternative chemical usage is advisable Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl

TABLE 8 (continued).—Variable Costs (Dollars) for Group I Plants *(Taxus)* for a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Machinery and Equipment (continued)					
	Sidedresser, 2-row	hr	0 63	7 53	5
	Cultivator, 2-row	hr	0 95	12 56	12
	Wagon, 4-wheel	hr	0 48	10 80	5
	Cultivator, 3-row	hr	13 93	1.38	19
	Truck, 1 /2-ton pickup	hr	8 42	346 67	2,919
	Flatbed truck, 24' bed	hr	14 87	26 98	401
Subtotal					5,894
Labor					
	Labor hours	hr	6 93**	1,369.51	9,491
	Related labor hours. 20%	hr	6.93	273.90	1,898
Subtotal					11,389
Interest Charge on Operating Capital	Computed at 12% on an annual basis for 6 months	%	6.0 (0.06)	24,079.00	1,445
Total Variable Costs					
Variable Cost per 18-24" Salable Plant	Units available for sale in a given year	ea		4,140.00	25,524 6.17

*Total nursery = 50 acres, with 40 acres of growing space and 10 acres in production facilities, holding and field bed area, roads, etc. Group I plants = 10 acres, with 8 acres of growing space and 2 acres in production facilities, holding and field bed area, roads, etc. 4,140 18-24" salable plants per year.

†Quantity discounts were applied to chemicals and other items.

‡7,914 plants would be stuck in the propagation house annually and about 23% would be lost over a 2-year period, leaving 6,088 for transplanting into liner beds. About 20% of the plants in the liner beds would be lost over a 3-year period, leaving 4,870 for transplanting into the field.

**Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

††To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

total annual fixed costs were divided by five. Annual fixed costs per salable plant were then determined by dividing the annual number of salable plants in each group into the annual fixed costs allocated to that group.

Variable Costs

Variable costs include all cost factors which vary with the quantity of plants being grown at one point in time. For example, the number of liners required for spring planting depends upon the quantity of plants management desires to have in inventory plus production losses. The loss factor for propagation in the case of the shrubs (plant categories I, II, and III) was estimated at 23% (1.3 stock cuttings to produce a healthy rooted cutting for lining out). The loss factor for shrubs in the bedding area was estimated at 20% (1.25 rooted cuttings would need to be planted in the bedding area for each healthy plant available for transplanting into the field). Field losses from the time of planting until shipping were estimated at 15% for the shrubs (plant groups I, II, and III), and at 10% for the trees (plant groups IV and V).

Variable costs were subdivided into the following categories: propagation for the shrub groups, materials, machinery and equipment, labor, and interest on operating capital. These costs were determined for each group of plants using a specific plant as the representative for the group (Tables 8-12a).

Propagation. Propagation costs were made up of rooting media (sand), labor for collecting, stripping, sticking, maintenance, harvesting, and for hormone powder.

Liners. For the shrubs (plant groups I, II, and III) liners were produced at the nursery. For the trees (plant groups IV and V) they were purchased. Two costs comprise the total for purchased liners. The major cost is the purchase price. While price is somewhat dependent upon quality and quantity, it was assumed that sufficient quantity would be ordered in either size nursery to obtain them at the lowest possible cost. The second cost was for packing and shipping the liner from producer to purchaser. This was estimated at 10% of the purchase price in each group of plants.

Burlap and Twine. Burlap and twine were provided for "ball and burlapping" each plant produced. In addition, for groups IV and V wire baskets were purchased. The cost of the burlap, twine, and wire baskets reflects a delivered cost to the nursery.

Polyethylene Film. The cost of the white translucent film delivered to the nursery.

Strip Tags. Strip tags were provided for identifying plants by botanical name, common name, state where

TABLE 8a.—Variable Costs (Dollars) for Group I Plants *(Taxus)* for a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Propagation‡					
Rooting media	Sand	cu yd	6 50	18 00	117
Collecting, stripping and sticking	37,710 units @ 1200/hr	hr	6.93**	31 43	218
Maintenance	50% of total propagation maintenance hr	hr	6 93	400 00	2,772
Harvest	37,710 units @ 600/hr	hr	6.93	62 85	436
Hormone powder	#8, I.B A	lb	15.50	1 08	17
Subtotal					3,560
Materials					
Burlap	32" x 32" squares + twine	ea	0 45	18,156 00	8,170
Polyethylene film	4 mil white, 32' x 225'	ea	127.50	4 54	579
Strip tags	5/8" x 7" plastic strip tags	ea	0.02	18,156.00	363
Chemicals	Custom spread, custom blend: 45-0-0, 0-44-0, 0-0-60 (fertilizer)	ton	176.00	3 17	558
	Custom spread (lime)	ton	20.00	5 16	103
	Urea, 45-0-0- (fertilizer)	ton	220.00	5.50	1,210
	Soluble 20-20-20 (fertilizer)	ton	1,411.20	0.55	776
	Trifluralin 4 EC (Treflan) (herbicide)	gallon	33.49	1.40	47
	Simazine 80WP (Princep) (herbicide)	lb	3.75	79.58	298
	DCPA 75WP (Dacthal) (herbicide)	lb	6.37	208 89	1,331
	Malathion, 57EL (Cythion) (insecticide)	gallon	18.28	71.61	1,309
	Benomyl, 50WP (Benlate) (fungicide)	lb	14.17	24.75	351
	Carbaryl, 80WP (Sevin) (insecticide)	lb	6.09	119.36	727
	Chlorothalonil 10M cu ft (Termil) (fungicide)	canister	1.76	13.36	24
	Other (*i.e.*, Kelthane, Captan, Di-syston, Orthene, etc.)††				1,224
Subtotal					17,070
Machinery and Equipment					
	Tractor, 100 hp	hr	17.00	18.73	318
	Tractor, 60 hp	hr	11.68	23.77	278
	Tractor, 34 hp	hr	4.99	141.56	706
	Articulated loader/2,000 lb	hr	6.67	82.25	549
	Articulated loader/3,000 lb	hr	14.81	82.25	1,218
	Forks	hr	0.01	164.50	2
	Plow, 3-14"	hr	6.57	4.49	29
	Disk, 8' wide	hr	4.23	9.09	38
	Harrow, 10' wide	hr	8.45	0.67	6
	Cultimulcher, 10' wide	hr	24.70	1.34	33
	Spray rig with 10' boom	hr	2.77	12.01	33
	Transplanter, 3-row	hr	26.79	5.34	143
	Permanent irrigation/well and pump 100 hp	hr	7.60	118.00	897
	In-ground irrigation — bed/field area	hr	3.13	96.00	300
	Above-ground irrigation — bed area	hr	1.83	96.00	176
	In-ground irrigation — storage and holding	hr	5.65	12.00	68
	Above-ground irrigation — storage and holding	hr	11.05	12.00	133
	Traveler gun	hr	12.06	10.00	121
	Portable PTO pump, 40 hp (emergency)	hr		(no costs budgeted)	
	Airblast sprayer	hr	1.01	95.49	96
	Fertilizer injector	hr	12.39	4.50	56
	Transplanter, 2-row	hr	12.00	8.90	107
	Undercutter, bed	hr	1.16	5.13	6
	U-Blade	hr	17.56	1.65	29

*Total nursery = 200 acres, with 175 acres of growing space and 25 acres in production facilities, holding and field bed area, roads, etc. Group I plants = 40 acres, with 35 acres of growing space and 5 acres in production facilities, holding and field bed area, roads, etc., 18,156 18-24" salable plants per year.

†Quantity discounts were applied to chemicals and other items.

‡34,710 plants would be stuck in the propagation house and about 23% would be lost, leaving 26,700 for transplanting into liner beds. About 20% of the plants in the liner beds would be lost, leaving 21,360 for transplanting into the field.

**Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

††To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 8a (continued).—Variable Costs (Dollars) for Group I Plants *(Taxus)* for a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Machinery and Equipment (continued)					
	Sidedresser, 2-row	hr	0 63	33.00	21
	Cultivator, 2-row	hr	0.95	59 40	56
	Wagon, 4-wheel	hr	0.48	47.30	23
	Cultivator, 3-row	hr	13.93	6.03	84
	Truck, 1 /2-ton pickup	hr	8.42	520.00	4,378
	Flatbed truck, 24' bed	hr	14.87	123.38	1,835
Subtotal					11,739
Labor					
	Labor hours	hr	6.93**	5,356.02	37,117
	Related labor hours, 20%	hr	6.93	1,071 20	7,423
Subtotal					44,540
Interest Charge on Operating Capital	Computed at 12% on an annual basis for 6 months	%	6.0 (0.06)	76,909.00	4,615
Total Variable Costs					81,524
Variable Cost per 18-24" Salable Plant	Units available for sale in a given year	ea		18,156.00	4.49

*Total nursery = 200 acres, with 175 acres of growing space and 25 acres in production facilities, holding and field bed area, roads, etc Group I plants = 40 acres, with 35 acres of growing space and 5 acres in production facilities, holding and field bed area, roads, etc., 18,156 18-24" salable plants per year.

†Quantity discounts were applied to chemicals and other items.

‡34,710 plants would be stuck in the propagation house and about 23% would be lost, leaving 26,700 for transplanting into liner beds. About 20% of the plants in the liner beds would be lost, leaving 21,360 for transplanting into the field.

**Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

††To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

plant was grown, and nursery producer. Costs include printing and shipping charges.

Chemicals. Chemical costs were subdivided into three cultural programs. The first is the fertilizer. For field operations the price included custom spreading for a custom blend and lime. Price for urea included delivery to the nursery. The second is the herbicide, cost of which is the purchase price of the various pre-emergence and post-emergence materials. The third combines insecticides and fungicides. Purchase price reflects total cost for the chemicals as local distributors were assumed. A special category of "other" was included under chemicals. Adequate chemicals were budgeted for normal control of insects and diseases. The "other" category budgeted at 50% of the cost of the "normal" insecticides and fungicides was to take care of special problems.

Poultry Wire. Poultry wire was provided for the two tree categories to protect tree trunks from rabbit damage.

Machinery and Equipment. Variable machinery and equipment costs represent all costs incurred while equipment or machinery is in use. These costs are comprised of repair, fuel, and lubrication/filter (Table 13). Repair cost per hour was calculated by multiplying initial cost by a stated repair percentage divided by the estimated lifetime use of the machinery in the large nursery in hours. The same repair cost per hour was used for both sizes of nurseries. Fuel costs were determined by multiplying units of fuel used per hour by the price per unit. Filter/lubrication cost was estimated at a constant factor of 15% of calculated fuel cost. Summation of repair, fuel, and filter/lubrication costs results in total variable cost per hour of machinery or equipment usage.

Hourly Labor. The hourly basic wage was estimated at $5.25. An additional 32% or $1.68 was allocated for various fringe benefits, making a total hourly labor cost of $6.93. Each major production activity was allocated necessary labor hours to accomplish assigned tasks.

Cost Summaries

After all cost factors were determined, they were summarized based upon cost per salable plant by group and size of nursery.

TABLE 9.—Variable Costs (Dollars) for Group II Plants *(Juniperus)* for a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Propagation‡					
Rooting media	Sand	cu yd	6 50	12 00	78
Collecting, stripping and sticking	11,107 units @ 700/hr	hr	6 93**	6 60	46
Maintenance	25% of total propagation maintenance hr	hr	6 93	182 50	1,265
Harvest	11,107 units @ 500/hr	hr	6 93	22 21	154
Hormone powder	#3, I B.A	lb	11 70	0 32	4
Subtotal					1,547
Materials					
Field pot	32" x 32" squares + twine	ea	0 45	5,810 00	2,615
Polyethylene film	4 mil white, 32' x 225'	ea	127.50	1 45	185
Strip tags	5/8" x 7" plastic strip tags	ea	0.02	5,810.00	116
Chemicals	Custom spread, custom blend· 45-0-0, 0-44-0, 0-0-60 (fertilizer)	ton	176 00	1.02	180
	Custom spread (lime)	ton	20.00	1.80	36
	Urea, 45-0-0- (fertilizer)	ton	220.00	0.88	194
	Soluble 20-20-20 (fertilizer)	ton	1,411.20	0.12	169
	Trifluralin 4 EC (Treflan) (herbicide)	gallon	33.49	0.45	15
	Simazine 80WP (Princep) (herbicide)	lb	3.75	13.00	49
	DCPA 75WP (Dacthal) (herbicide)	lb	6.37	36.40	232
	Malathion, 57EL (Cythion) (insecticide)	gallon	18.28	11.70	214
	Benomyl, 50WP (Benlate) (fungicide)	lb	14.17	19.50	276
	Carbaryl, 80WP (Sevin) (insecticide)	lb	6.09	7.80	48
	Chlorothalonil 10M cu ft (Termil) (fungicide)	canister	1.76	4.55	8
	Other (*i.e.*, Kelthane, Captan, Di-syston, Orthene, etc.)††				
Subtotal					4,337
Machinery and Equipment					
	Tractor, 100 hp	hr	17.00	24.29	413
	Tractor, 34 hp	hr	4.99	37.31	186
	Articulated loader/3,000 lb	hr	14.81	49.77	737
	Forks	hr	0.01	49.77	1
	Plow, 3-14"	hr	6.57	1.44	9
	Disk, 8' wide	hr	4.23	3.48	15
	Harrow, 10' wide	hr	8.45	0.21	2
	Cultimulcher, 10' wide	hr	24.74	0.38	10
	Spray rig with 10' boom	hr	2.77	2.14	6
	Transplanter, 3-row	hr	26.79	1.71	46
	Permanent irrigation/well and pump 100 hp	hr	7.60	63.20	480
	In-ground irrigation — bed area	hr	3.13	48.00	150
	Above-ground irrigation — bed area	hr	1.83	48.00	88
	In-ground irrigation — storage/holding	hr	5.65	12.00	68
	Above-ground irrigation — storage/holding	hr	11.05	12.00	133
	Traveler gun	hr	12.06	3.20	39
	Portable PTO pump, 40 hp	hr		(no costs budgeted)	
	Airblast sprayer	hr	1.01	15.60	16
	Fertilizer injector	hr	12.39	3.00	37
	Transplanter, 2-row	hr	12.00	2.84	34
	Undercutter, bed	hr	1.16	1.64	2
	Sidedresser, 2-row	hr	0.63	4.80	3
	Cultivator, 2-row	hr	0.95	9.51	9
	Wagon, 4-wheel	hr	0.48	15.12	7

*Total nursery = 50 acres, with 40 acres of growing space and 10 acres in production facilities, holding and field bed area, roads, etc.
Group I plants = 10 acres, with 8 acres of growing space and 2 acres in production facilities, holding and field bed area, roads, etc., 5,810 18-24" salable plants per year.

†Quantity discounts were applied to chemicals and other items.

‡11,107 plants would be stuck in the propagation house and about 23% would be lost, leaving 8,544 for transplanting into liner beds. About 20% of the plants in the liner beds would be lost, leaving 6,835 for transplanting into the field.

**Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

††To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 9 (continued).—Variable Costs (Dollars) for Group II Plants *(Juniperus)* for a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Machinery and Equipment (continued)					
	Cultivator, 3-row	hr	13.93	1 32	18
	Truck, 1/2-ton pickup	hr	8.42	346 67	2,919
	Flatbed truck, 24' bed	hr	14 87	36 47	542
Subtotal					5,970
Labor					
	Labor hours	hr	6.93**	1,491 56	10,337
	Related labor hours, 20%	hr	6 93	298.00	2,065
Subtotal					12,402
Interest Charge on Operating Capital	Computed at 12% on an annual basis for 6 months	%	6.0 (0.06)	24,256.00	1,456
Total Variable Costs					25,712
Variable Cost per 18-24" Salable Plant	Units available for sale in a given year	ea		5,810.00	4.42

*Total nursery = 50 acres, with 40 acres of growing space and 10 acres in production facilities, holding and field bed area, roads, etc. Group II plants = 10 acres, with 8 acres of growing space and 2 acres in production facilities, holding and field bed area, roads, etc., 5,810 18-24" salable plants per year.

†Quantity discounts were applied to chemicals and other items.

‡11,107 plants would be stuck in the propagation house and about 23% would be lost, leaving 8,544 for transplanting into liner beds. About 20% of the plants in the liner beds would be lost, leaving 6,835 for transplanting into the field.

**Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

††To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 9a.—Variable Costs (Dollars) for Group II Plants *(Juniperus)* for a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Propagation‡					
Rooting media	Sand	cu yd	6 50	24 00	156
Collecting, stripping and sticking	48,594 units @ 700/hr	hr	6 93**	69 42	481
Maintenance	25% of total propagation maintenance hr	hr	6.93	200 00	1,386
Harvest	48,594 units @ 500/hr	hr	6 93	97 19	674
Hormone powder	#3, I.B A.	lb	11 70	1 39	16
Subtotal					2,713
Materials					
Burlap	32" x 32" squares + twine	ea	0 45	25,418 00	11,438
Polyethylene film	4 mil white, 32' x 225'	ea	127 50	6 35	810
Strip tags	5/8" x 7" plastic strip tags	ea	0 02	25,418 00	508
Chemicals	Custom spread, custom blend 45-0-0, 0-44-0, 0-0-60 (fertilizer)	ton	176 00	4 44	781
	Custom spread (lime)	ton	20 00	4 95	99
	Urea, 45-0-0- (fertilizer)	ton	220 00	4.95	1,089
	Soluble 20-20-20 (fertilizer)	ton	1,411.20	0.52	734
	Trifluralin 4 EC (Treflan) (herbicide)	gallon	33 49	1.97	66
	Simazine 80WP (Princep) (herbicide)	lb	3 75	61 10	229
	DCPA 75WP (Dacthal) (herbicide)	lb	6.37	159.04	1,013
	Malathion, 57EL (Cythion) (insecticide)	gallon	18.28	48.59	888
	Benomyl, 50WP (Benlate) (fungicide)	lb	14.17	32.36	459
	Carbaryl, 80WP (Sevin) (insecticide)	lb	6.09	80.90	493
	Chlorothalonil 10M cu ft (Termil) (fungicide)	canister	1.76	19.05	34
	Other (*i.e.*, Kelthane, Captan, Di-syston, Orthene, etc.)††				920
Subtotal					19,561
Machinery and Equipment					
	Tractor, 100 hp	hr	17.00	26.23	446
	Tractor, 60 hp	hr	11.68	79.25	926
	Tractor, 34 hp	hr	4.99	142.18	709
	Articulated loader/2,000 lb	hr	6.67	49.88	333
	Articulated loader/3,000 lb	hr	14.81	49.88	739
	Forks	hr	0.01	99.67	1
	Plow, 3-14"	hr	6.57	6.29	41
	Disk, 8' wide	hr	4.23	10.84	46
	Harrow, 10' wide	hr	8.45	0.94	8
	Cultimulcher, 10' wide	hr	24.70	1.65	41
	Spray rig with 10' boom	hr	2.77	9.37	26
	Transplanter, 3-row	hr	26.79	7.48	200
	Permanent irrigation/well and pump 100 hp	hr	7.60	88.00	669
	In-ground irrigation — bed area	hr	3.13	62.00	194
	Above-ground irrigation — bed area	hr	1.83	62.00	113
	In-ground irrigation — storage/holding	hr	5.65	12.00	68
	Above-ground irrigation — storage/holding	hr	11.05	12.00	133
	Traveler gun	hr	12.06	14.00	169
	Portable PTO pump, 40 hp	hr		(no costs budgeted)	
	Airblast sprayer	hr	1.01	68.16	69
	Fertilizer injector	hr	12.39	3.00	37
	Transplanter, 2-row	hr	12.00	12.46	150
	Undercutter, bed	hr	1.16	7.19	8

*Total nursery = 200 acres, with 175 acres of growing space and 25 acres in production facilities, holding and field bed area, roads, etc. Group II plants = 40 acres, with 35 acres of growing space and 5 acres in production facilities, holding and field bed area, roads, etc., 25,418 18-24" salable plants per year.

·†Quantity discounts were applied to chemicals and other items.

‡48,594 plants would be stuck in the propagation house and about 23% would be lost, leaving 37,380 for transplanting into liner beds. About 20% of the plants in the liner beds would be lost, leaving 29,904 for transplanting into the field.

**Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

††To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 9a (continued).—Variable Costs (Dollars) for Group II Plants *(Juniperus)* for a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Machinery and Equipment (continued)					
	Undercutter, bed	hr	1 16	7 19	8
	Sidedresser, 2-row	hr	0.63	21.00	13
	Cultivator, 2-row	hr	0 95	41.58	40
	Wagon, 4-wheel	hr	0 48	66.20	32
	Cultivator, 3-row	hr	13 93	5.68	79
	Truck, 1/2-ton pickup	hr	8 42	520.00	4,378
	Flatbed truck, 24' bed	hr	14 87	159.48	2,371
Subtotal					12,039
Labor					
	Labor hours	hr	6.93**	6,271.93	43,465
	Related labor hours, 20%	hr	6.93	1,254.38	8,693
Subtotal					52,158
Interest Charge on Operating Capital	Computed at 12% on an annual basis for 6 months	%	6.0 (0.06)	86,471.00	5,188
Total Variable Costs					91,659
Variable Cost per 18-24" Salable Plant	Units available for sale in a given year	ea		25,418.00	3.61

*Total nursery = 200 acres, with 175 acres of growing space and 25 acres in production facilities, holding and field bed area, roads, etc. Group II plants = 40 acres, with 35 acres of growing space and 5 acres in production facilities, holding and field bed area, roads, etc., 25,418 18-24" salable plants per year.

†Quantity discounts were applied to chemicals and other items.

‡48,594 plants would be stuck in the propagation house and about 23% would be lost, leaving 37,380 for transplanting into liner beds. About 20% of the plants in the liner beds would be lost, leaving 29,904 for transplanting into the field.

**Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

††To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 10.—Variable Costs (Dollars) for Group III Plants *(Viburnum)* for a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Propagation‡					
Rooting media	Sand	cu yd	6.50	12 00	78
Collecting, stripping and sticking	11,869 units @ 1000/hr	hr	6 93**	11.87	82
Maintenance	25% of total propagation maintenance hr	hr	6.93	182 50	1,265
Harvest	11,869 units @ 400/hr	hr	6.93	29.68	206
Hormone powder	#1, I.B.A.	lb	8 00	0 34	3
Subtotal					1,634
Materials					
Burlap	32" x 32" squares + twine	ea	0 45	6,208.00	2,794
Polyethylene film	4 mil white, 32' x 225'	ea	127 50	1.55	198
Strip tags	5/8" x 7" plastic strip tags	ea	0.02	6,208.00	124
Chemicals	Custom spread, custom blend: 45-0-0, 0-44-0, 0-0-60 (fertilizer)	ton	176.00	1.25	220
	Custom spread (lime)	ton	20.00	1 21	24
	Urea, 45-0-0- (fertilizer)	ton	220.00	0 66	145
	Soluble 20-20-20 (fertilizer)	ton	1,411.20	0.06	85
	Trifluralin 4 EC (Treflan) (herbicide)	gallon	33.49	0 55	18
	Simazine 80WP (Princep) (herbicide)	lb	3.75	15.53	58
	DCPA 75WP (Dacthal) (herbicide)	lb	6.37	43.47	227
	Malathion, 57EL (Cythion) (insecticide)	gallon	18.28	13.97	255
	Benomyl, 50WP (Benlate) (fungicide)	lb	14.17	9.32	132
	Carbaryl, 80WP (Sevin) (insecticide)	lb	6.09	23.29	142
	Chlorothalonil 10M cu ft (Termil) (fungicide)	canister	1.76	4.65	8
	Other (*i.e.*, Kelthane, Captan, Di-syston, Orthene, etc.)††				265
Subtotal					4,745
Machinery and Equipment					
	Tractor, 100 hp	hr	17.00	35.58	605
	Tractor, 34 hp	hr	4.99	34.44	172
	Articulated loader/3,000 lb	hr	14.81	57.78	856
	Forks	hr	0.01	57.78	1
	Plow, 3-14"	hr	6.57	1.77	12
	Disk, 8' wide	hr	4.23	3.58	15
	Harrow, 10' wide	hr	8.45	0.27	2
	Cultimulcher, 10' wide	hr	24.70	0.54	13
	Spray rig with 10' boom	hr	2.77	2.57	7
	Transplanter, 3-row	hr	26.79	1.83	49
	Permanent irrigation/well and pump 100 hp	hr	7.60	40.00	304
	In-ground irrigation — bed area	hr	3.13	24.00	75
	Above-ground irrigation — bed area	hr	1.83	24.00	44
	In-ground irrigation — storage/holding	hr	5.65	12.00	68
	Above-ground irrigation — storage/holding	hr	11.05	12.00	133
	Traveler gun	hr	12.06	4.00	48
	Portable PTO pump, 40 hp	hr		(no costs budgeted)	
	Airblast sprayer	hr	1.01	18.63	19
	Fertilizer injector	hr	12.39	1.50	19
	Transplanter, 2-row	hr	12.00	3.04	36
	Undercutter, bed	hr	1.61	1.76	3
	Sidedresser, 2-row	hr	0.63	3.60	2
	Cultivator, 2-row	hr	0.95	11.88	11
	Wagon, 4-wheel	hr	0.48	16.16	8

*Total nursery = 50 acres, with 40 acres of growing space and 10 acres in production facilities, holding and field bed area, roads, etc.
Group III plants = 10 acres, with 8 acres of growing space and 2 acres in production facilities, holding and field bed area, roads, etc., 6,208 salable plants (3-4' in height) per year.

†Quantity discounts were applied to chemicals and other items.

‡11,869 plants would be stuck in the propagation house and about 23% would be lost, leaving 9,130 for transplanting into liner beds. About 20% of the plants in the liner beds would be lost, leaving 7,304 for transplanting into the field.

**Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

††To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 10 (continued).—Variable Costs (Dollars) for Group III Plants *(Viburnum)* for a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Machinery and Equipment (continued)					
	Cultivator, 3-row	hr	13.93	0 69	10
	Truck, 1/2-ton pickup	hr	8 42	346 71	2,919
	Flatbed truck, 24' bed	hr	14.87	35 92	534
Subtotal					5,965
Labor					
	Labor hours	hr	6.93**	1,651.59	11,446
	Related labor hours, 20%	hr	6.93	330.32	2,289
Subtotal					13,735
Interest Charge on Operating Capital	Computed at 12% on an annual basis for 6 months	%	6 0 (0.06)	26,079 00	1,565
Total Variable Costs					27,644
Variable Cost per 3-4' Salable Plant	Units available for sale in a given year	ea		6,208.00	4.45

*Total nursery = 50 acres, with 40 acres of growing space and 10 acres in production facilities, holding and field bed area, roads, etc. Group III plants = 10 acres, with 8 acres of growing space and 2 acres in production facilities, holding and field bed area, roads, etc., 6,208 salable plants (3-4' in height) per year.

†Quantity discounts were applied to chemicals and other items.

‡11,869 plants would be stuck in the propagation house and about 23% would be lost, leaving 9,130 for transplanting into liner beds. About 20% of the plants in the liner beds would be lost, leaving 7,304 for transplanting into the field.

**Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

††To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 10a.—Variable Costs (Dollars) for Group III Plants *(Viburnum)* for a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Propagation‡					
Rooting media	Sand	cu yd	6 50	24 00	156
Collecting, stripping and sticking	51,927 units @ 1000/hr	hr	6 93**	51 93	360
Maintenance	25% of total propagation maintenance hr	hr	6 93	200 00	1,386
Harvest	51,927 units @ 400/hr	hr	6 93	129 93	900
Hormone powder	#1, I.B.A	lb	8 00	1 49	12
Subtotal					2,814
Materials					
Burlap	32" x 32" squares + twine	ea	0 45	27,162 00	12,223
Polyethylene film	4 mil white, 32' x 225'	ea	127 50	6 79	866
Strip tags	5/8" x 7" plastic strip tags	ea	0 02	27,162 00	543
Chemicals	Custom spread, custom blend. 45-0-0, 0-44-0, 0-0-60 (fertilizer)	ton	176 00	5 46	961
	Custom spread (lime)	ton	20 00	9.67	193
	Urea, 45-0-0- (fertilizer)	ton	220 00	2 89	636
	Soluble 20-20-20 (fertilizer)	ton	1,411 20	0 28	395
	Trifluralin 4 EC (Treflan) (herbicide)	gallon	33 49	2 42	81
	Simazine 80WP (Princep) (herbicide)	lb	3 75	67 93	255
	DCPA 75WP (Dacthal) (herbicide)	lb	6.37	190.19	1,212
	Malathion, 57EL (Cythion) (insecticide)	gallon	18 28	61 13	1,117
	Benomyl, 50WP (Benlate) (fungicide)	lb	14 17	40 76	578
	Carbaryl, 80WP (Sevin) (insecticide)	lb	6.09	101 89	621
	Chlorothalonil 10M cu ft (Termil) (fungicide)	canister	1.76	20 37	36
	Other (*i.e.*, Kelthane, Captan, Di-syston, Orthene, etc.)††				1,158
Subtotal					20,875
Machinery and Equipment					
	Tractor, 100 hp	hr	17.00	29.04	494
	Tractor, 60 hp	hr	11.68	125.56	1,467
	Tractor, 34 hp	hr	4 99	156 04	779
	Articulated loader/2,000 lb	hr	6.67	126 42	843
	Articulated loader/3,000 lb	hr	14.81	126.42	1,872
	Forks	hr	0.01	252.83	3
	Plow, 3-14"	hr	6.57	7.74	51
	Disk, 8' wide	hr	4.23	15.67	66
	Harrow, 10' wide	hr	8.45	1.16	10
	Cultimulcher, 10' wide	hr	24.70	2.28	56
	Spray rig with 10' boom	hr	2.77	11.28	31
	Transplanter, 3-row	hr	26.79	7.99	214
	Permanent irrigation/well and pump 100 hp	hr	7.60	61.50	467
	In-ground irrigation — bed area	hr	3 13	32.00	100
	Above-ground irrigation — bed area	hr	1.83	32.00	59
	In-ground irrigation — storage/ holding	hr	5.65	12.00	68
	Above-ground irrigation — storage/ holding	hr	11.05	12.00	133
	Traveler gun	hr	12.06	17.50	211
	Portable PTO pump, 40 hp	hr		(no costs budgeted)	
	Airblast sprayer	hr	1.01	78.75	80
	Fertilizer injector	hr	12.39	1.50	19
	Transplanter, 2-row	hr	12.00	13.31	160
	Undercutter, bed	hr	1.16	7.68	9

*Total nursery = 200 acres, with 175 acres of growing space and 25 acres in production facilities, holding and field bed area, roads, etc. Group III plants = 40 acres, with 35 acres of growing space and 5 acres in production facilities, holding and field bed area, roads, etc., 27,162 salable plants (3-4' in height) per year.

†Quantity discounts were applied to chemicals and other items.

‡51,927 plants would be stuck in the propagation house and about 23% would be lost, leaving 39,944 for transplanting into liner beds. About 20% of the plants in the liner beds would be lost, leaving 31,955 for transplanting into the field.

**Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

††To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 10a (continued).—Variable Costs (Dollars) for Group III Plants *(Viburnum)* for a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Machinery and Equipment (continued)					
	Sidedresser, 2-row	hr	0.63	15.75	10
	Cultivator, 2-row	hr	0.95	34.66	33
	Wagon, 4-wheel	hr	0.48	70.76	34
	Cultivator, 3-row	hr	13.93	3.04	42
	Truck, 1/2-ton pickup	hr	8.42	533.31	4,490
	Flatbed truck, 24' bed	hr	14.87	157.14	2,337
Subtotal					14,138
Labor					
	Labor hours	hr	6.93**	7,165.73	49,658
	Related labor hours, 20%	hr	6.93	1,433.15	9,932
Subtotal					59,590
Interest Charge on Operating Capital	Computed at 12% on an annual basis for 6 months	%	6.0 (0.06)	97,417.00	5,845
Total Variable Costs					103,262
Variable Cost per 3-4" Salable Plant	Units available for sale in a given year	ea		27,162.00	3.80

*Total nursery = 200 acres, with 175 acres of growing space and 25 acres in production facilities, holding and field bed area, roads, etc. Group III plants = 40 acres, with 35 acres of growing space and 5 acres in production facilities, holding and field bed area, roads, etc., 27,162 salable plants (3-4' in height) per year.

†Quantity discounts were applied to chemicals and other items.

‡51,927 plants would be stuck in the propagation house and about 23% would be lost, leaving 39,944 for transplanting into liner beds. About 20% of the plants in the liner beds would be lost, leaving 31,955 for transplanting into the field.

**Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

††To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 11.—Variable Costs (Dollars) for Group IV Plants *(Acer rubrum)* for a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Materials					
Burlap	54" x 54" squares + 24" basket	ea	3 10	1,869 00	5 794
Twine	Nails + twine	ea	0.15	1,869 00	280
Liners	6-8' 2 yr branched	ea	11.09	2,076.00	23,023
Strip tags	5/8" x 7" plastic strip tags	ea	0 02	1,869.00	37
Poultry wire	1" for rabbit control	roll	29.00	2 00	58
Seed	Ryegrass (Kentucky 31)	lb	0 64	348 48	223
Chemicals	Custom spread, custom blend: 45-0-0, 0-44-0, 0-0-60 (fertilizer)	ton	176 00	0.90	158
	Custom spread (lime)	ton	20 00	1.60	32
	Urea, 45-0-0- (fertilizer)	ton	220 00	0.70	154
	Trifluralin 4 EC (Treflan) (herbicide)	gallon	33 49	0.40	13
	Simazine 80WP (Princep) (herbicide)	lb	3 75	16.00	60
	DCPA 75WP (Dacthal) (herbicide)	lb	6 37	47.04	300
	Malathion, 57EL (Cythion) (insecticide)	gallon	18.28	14.40	263
	Benomyl, 50WP (Benlate) (fungicide)	lb	14 17	9.60	136
	Carbaryl, 80WP (Sevin) (insecticide)	lb	6.09	24.00	146
	Other (*i.e.*, Kelthane, Captan, Di-syston, Orthene, etc.)**				272
Subtotal					30,949
Machinery and Equipment					
	Tractor, 100 hp	hr	17.00	49.84	847
	Tractor, 34 hp	hr	4.99	22.86	114
	Flatbed truck, 24' bed	hr	14.87	125.76	1,870
	Articulated loader/3,000 lb	hr	14.81	54.89	813
	Tree spade	hr	5.30	125.79	667
	Forks	hr	0.01	54.89	1
	Plow, 3-14"	hr	6.57	1.28	8
	Disk, 8' wide	hr	4.23	2.28	10
	Harrow, 10' wide	hr	8.45	0.19	2
	Cultimulcher, 10' wide	hr	24.70	0.34	8
	Spray rig with 10' boom	hr	2.77	2.50	7
	Transplanter, 1-row (tree)	hr	0.92	37.75	35
	Permanent irrigation/well and pump 100 hp	hr	7.60	15.20	116
	In-ground irrigation—storage/holding	hr	5.56	12.00	67
	Above-ground irrigation—storage/holding	hr	11.05	12.00	133
	In-ground irrigation — bed/field	hr	3.13	3.20	10
	Traveler gun	hr	12.06	3.20	39
	Portable PTO pump, 40 hp	hr		(no costs budgeted)	
	Airblast sprayer	hr	1.01	19.20	19
	Mower	hr	2.98	4.36	13
	Seeder	hr	1.05	2.16	2
	Sidedresser, 2-row	hr	0.63	3.84	2
	Cultivator, 2-row	hr	0.95	4.24	4
	Wagon, 4-wheel	hr	0.48	6.10	3
	Truck, 1 /2-ton pickup	hr	8.42	384.42	3,237
	Flatbed truck, 24' bed	hr	14.87	125.76	1,870
Subtotal					9,897

*Total nursery = 50 acres, with 40 acres of growing space and 10 acres in production facilities, holding and field bed area, roads, etc. Group IV plants = 10 acres, with 8 acres of growing space and 2 acres in production facilities, holding and field bed area, roads, etc., 1,869 2" caliper salable plants per year.

†Quantity discounts were applied to chemicals and other items.

‡Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

**To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 11 (continued).—Variable Costs (Dollars) for Group IV Plants *(Acer rubrum)* for a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Labor					
	Labor hours	hr	6.93‡	1,340.44	9,290
	Related labor hours, 20%	hr	6.93	268.00	1,858
Subtotal					11,148
Interest Charge on Operating Capital	Computed at 12% on an annual basis for 6 months	%	6.0 (0.06)	51,994.00	3,120
Total Variable Costs					55,114
Variable Cost per Salable Plant (2" Caliper)	Units available for sale in a given year	ea		1,869.00	29.49

*Total nursery = 50 acres, with 40 acres of growing space and 10 acres in production facilities, holding and field bed area, roads, etc. Group IV plants = 10 acres, with 8 acres of growing space and 2 acres in production facilities, holding and field bed area, roads, etc., 1,869 2" caliper salable plants per year.

†Quantity discounts were applied to chemicals and other items.

‡Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

**To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 11a.—Variable Costs (Dollars) for Group IV Plants *(Acer rubrum)* for a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Materials					
Burlap	54" x 54" squares + 24" basket	ea	3.10	8,177.00	25,349
Twine	Nails + twine	ea	0.15	8,177.00	1,227
Liners	6-8' 2 yr branched	ea	8.68	9,086.00	78,866
Strip tags	5/8" x 7" plastic strip tags	ea	0.02	8,177.00	164
Poultry wire	1" poultry wire for rabbit control	roll	29.00	9.00	261
Seed	Ryegrass (Kentucky 31)	lb	0.64	1,524.60	976
Chemicals	Custom spread, custom blend: 45-0-0, 0-44-0, 0-0-60 (fertilizer)	ton	176.00	3.95	695
	Custom spread (lime)	ton	20.00	7.00	140
	Urea, 45-0-0 (fertilizer)	ton	220.00	3.08	678
	Trifluralin 4 EC (Treflan) (herbicide)	gallon	33.49	1.75	59
	Simazine 80WP (Princep) (herbicide)	lb	3.75	70.00	263
	DCPA 75WP (Dacthal) (herbicide)	lb	6.37	196.00	1,249
	Malathion, 57EL (Cythion) (insecticide)	gallon	18.28	63.00	1,152
	Benomyl, 50WP (Benlate) (fungicide)	lb	14.17	42.00	595
	Carbaryl, 80WP (Sevin) (insecticide)	lb	6.09	105.00	639
	Other (*i.e.*, Kelthane, Captan, Di-syston, Orthene, etc.)**				1,193
Subtotal					113,506

*Total nursery = 200 acres, with 175 acres of growing space and 25 acres in production facilities, holding and field bed area, roads, etc. Group IV plants = 40 acres, with 35 acres of growing space and 5 acres in production facilities, holding and field bed area, roads, etc. 8,177 2" caliper salable plants per year.

†Quantity discounts were applied to chemicals and other items.

‡Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

*To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 11a (continued).—Variable Costs (Dollars) for Group IV Plants *(Acer rubrum)* for a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Machinery and Equipment					
	Tractor, 100 hp	hr	17 00	170 82	2,904
	Tractor, 60 hp	hr	11 68	102 20	1,194
	Tractor, 34 hp	hr	4 99	88 85	443
	Articulated loader/2,000 lb	hr	6 67	108 75	725
	Articulated loader/3,000 lb	hr	14 81	108 75	1,611
	Tree spade	hr	5 30	543 07	2,878
	Forks	hr	0 01	217 49	2
	Plow, 3-14"	hr	6 57	5 60	37
	Disk, 8' wide	hr	4.23	9 45	40
	Harrow, 10' wide	hr	8 45	0 84	7
	Cultimulcher, 10' wide	hr	24 70	1 47	36
	Spray rig with 10' boom	hr	2 77	10 99	30
	Transplanter, 1-row (tree)	hr	0 92	165 20	152
	Permanent irrigation/well and pump 100 hp	hr	7.60	26.00	198
	In-ground irrigation—storage/ holding	hr	5.65	12.00	68
	Above-ground irrigation—storage/ holding	hr	11.05	12.00	133
	In-ground irrigation — bed/field	hr	3.13	14.00	44
	Traveler gun	hr	12.06	14.00	169
	Portable PTO pump, 40 hp	hr	3 75	3 40	13
	Airblast sprayer	hr	1.01	84.00	85
	Seeder	hr	1.05	4.76	5
	Mower	hr	2.98	19.04	57
	Sidedresser, 2-row	hr	0.63	16.80	11
	Cultivator, 2-row	hr	0.95	18.48	18
	Wagon, 4-wheel	hr	0.48	26.20	13
	Truck, 1/2-ton pickup	hr	8.42	685.20	5,769
	Flatbed truck, 24' bed	hr	14.87	545.07	8,105
Subtotal					24,747
Labor					
	Labor hours	hr	6.93‡	6,320.04	43,789
	Related labor hours, 20%	hr	6.93	1,264.00	8,760
Subtotal					52,558
Interest Charge On Operating Capital	Computed at 12% on an annual basis for six months	%	6.0 (0.06)	190,811.00	11,449
Total Variable Costs					202,260
Variable Cost per Salable Plant (2" Caliper)	Units available for sale in a given year	ea		8,177.00	24.74

*Total nursery = 200 acres, with 175 acres of growing space and 25 acres in production facilities, holding and field bed area, roads, etc. Group IV plants = 40 acres, with 35 acres of growing space and 5 acres in production facilities, holding and field bed area, roads, etc. 8,177 2" caliper salable plants per year.

†Quantity discounts were applied to chemicals and other items.

‡Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

*To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 12.—Variable Costs (Dollars) for Group V Plants *(Malus)* for a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Materials					
Burlap	54" x 54" squares + 18" basket	ea	2.53	2,732.00	6,912
Twine	Nails + twine	ea	0.15	2,732.00	410
Liners	5'-6' 2 yr branched	ea	6.00	3,036.00	18,216
Strip tags	5/8" x 7" plastic strip tags	ea	0.02	2,732.00	55
Poultry wire	1" poultry wire for rabbit control	roll	29.00	2.00	58
Seed	Ryegrass (Kentucky 31)	lb	0.64	435.60	279
Chemicals	Custom spread, custom blend· 45-0-0, 0-44-0, 0-0-60 (fertilizer)	ton	176.00	1.13	199
	Custom spread (lime)	ton	20.00	2.00	40
	Urea, 45-0-0 (fertilizer)	ton	220.00	0.66	145
	Trifluralin 4 EC (Treflan) (herbicide)	gallon	33.49	0.50	17
	Simazine 80WP (Princep) (herbicide)	lb	3.75	15.00	56
	DCPA 75WP (Dacthal) (herbicide)	lb	6.37	44.10	281
	Malathion, 57EL (Cythion) (insecticide)	gallon	18.28	13.50	247
	Benomyl, 50WP (Benlate) (fungicide)	lb	14.17	9.50	135
	Carbaryl, 80WP (Sevin) (insecticide)	lb	6.09	22.50	137
	Other (*i.e.*, Kelthane, Captan, Di-syston, Orthene, etc.)**				260
Subtotal					27,447
Machinery and Equipment					
	Tractor, 100 hp	hr	17.00	68.48	1,164
	Tractor, 60 hp	hr	11.68	17.06	199
	Tractor, 34 hp	hr	4.99	41.78	208
	Articulated loader/3,000 lb	hr	14.81	92.10	1,364
	Tree spade	hr	5.30	102.57	544
	Forks	hr	0.01	92.10	1
	Plow, 3-14"	hr	6.57	1.60	11
	Disk, 8' wide	hr	4.23	3.24	14
	Harrow, 10' wide	hr	8.45	0.24	2
	Cultimulcher, 10' wide	hr	24.70	0.49	12
	Spray rig with 10' boom	hr	2.77	2.46	7
	Transplanter, 1-row (tree)	hr	0.92	55.20	51
	Permanent irrigation/well and pump 100 hp	hr	7.60	16.00	122
	In-ground irrigation—storage/holding	hr	5.65	12.00	68
	Above-ground irrigation—storage/holding	hr	11.05	12.00	133
	In-ground irrigation — bed/field	hr	3.13	4.00	13
	Traveler gun	hr	12.06	4.00	48
	Portable PTO pump, 40 hp	hr		(no costs budgeted)	
	Airblast sprayer	hr	1.01	18.00	18
	Seeder	hr	1.05	1.02	1
	Mower	hr	2.98	4.08	12
	Sidedresser, 2-row	hr	0.63	3.60	2
	Cultivator, 2-row	hr	0.95	3.96	4
	Wagon, 4-wheel	hr	0.48	8.16	4
	Truck, 1/2-ton pickup	hr	8.42	346.67	2,919
	Flatbed truck, 24' bed	hr	14.87	157.77	2,346
Subtotal					9,267

*Total nursery = 50 acres, with 40 acres of growing space and 10 acres in production facilities, holding and field bed area, roads, etc. Group V plants = 10 acres, with 8 acres of growing space and 2 acres in production facilities, holding and field bed area, roads, etc. 2,732 1-1/2" caliper salable plants per year.

†Quantity discounts were applied to chemicals and other items.

‡Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

**To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 12 (continued).—Variable Costs (Dollars) for Group V Plants *(Malus)* for a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Labor					
	Labor hours	hr	6.93‡	1,674 91	11,607
	Related labor hours, 20%	hr	6 93	335 00	2,322
Subtotal					13,929
Interest Charge On Operating Capital	Computed at 12% on an annual basis for six months	%	6 0 (0 06)	50,643 00	3 039
Total Variable Costs					53,682
Variable Cost per Salable Plant (1-1/2" Caliper)	Units available for sale in a given year	ea		2,732 00	19.65

*Total nursery = 50 acres, with 40 acres of growing space and 10 acres in production facilities, holding and field bed area, roads, etc
Group V plants = 10 acres, with 8 acres of growing space and 2 acres in production facilities, holding and field bed area, roads, etc.
2,732 1-1/2" caliper salable plants per year.
†Quantity discounts were applied to chemicals and other items.
‡Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.
**To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 12a.—Variable Costs (Dollars) for Group V Plants *(Malus)* for a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Materials					
Burlap	54" x 54" squares + 18" basket	ea	2.53	11,954.00	30,244
Twine	Nails + twine	ea	.15	11,954.00	1,793
Liners	5-6' 2 yr branched	ea	4.86	13,283.00	64,555
Strip tags	5/8" x 7" plastic strip tags	ea	0.02	11,954.00	239
Poultry wire	1" for rabbit control	roll	29.00	9.00	261
Seed	Ryegrass (Kentucky 31)	lb	0.64	1,905.75	1,220
Chemicals	Custom spread, custom blend: 45-0-0, 0-44-0, 0-0-60 (fertilizer)	ton	176.00	4.94	869
	Custom spread (lime)	ton	20.00	8.75	175
	Urea, 45-0-0 (fertilizer)	ton	220.00	3.85	847
	Trifluralin 4 EC (Treflan) (herbicide)	gallon	33.49	8.75	293
	Simazine 80WP (Princep) (herbicide)	lb	3.75	87.50	328
	DCPA 75WP (Dacthal) (herbicide)	lb	6.37	245.00	1,561
	Malathion, 57EL (Cythion) (insecticide)	gallon	18.28	78.75	1,440
	Benomyl, 50WP (Benlate) (fungicide)	lb	14.17	131.25	1,860
	Carbaryl, 80WP (Sevin) (insecticide)	lb	6.09	52.50	320
	Other (*i.e.*, Kelthane, Captan, Di-syston, Orthene, etc.)**				1,810
Subtotal					107,815

*Total nursery = 200 acres, with 175 acres of growing space and 25 acres in production facilities, holding and field bed area, roads, etc.
Group V plants = 40 acres, with 35 acres of growing space and 5 acres in production facilities, holding and field bed area, roads, etc.,
11,954 1-1/2" salable plants per year.
†Quantity discounts were applied to chemicals and other items.
‡Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.
**To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 12a (continued).—Variable Costs (Dollars) for Group V Plants *(Malus)* for a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Description	Unit	Cost per Unit† ($)	Quantity	Total Variable Cost ($)
Machinery and Equipment					
	Tractor, 100 hp	hr	17.00	248.51	4,225
	Tractor, 60 hp	hr	11.68	252.38	2,948
	Tractor, 34 hp	hr	4.99	102.65	512
	Articulated loader/2,000 lb	hr	6.67	157.26	1,049
	Articulated loader/3,000 lb	hr	14.81	157.87	2,338
	Tree spade	hr	5.30	475.16	2,518
	Forks	hr	0.01	314.52	3
	Plow, 3-14"	hr	6.57	7.00	46
	Disk, 8' wide	hr	4.23	14.18	60
	Harrow, 10' wide	hr	8.45	1.05	9
	Cultimulcher, 10' wide	hr	24.70	2.02	50
	Spray rig with 10' boom	hr	2.77	13.76	38
	Transplanter, 1-row (tree)	hr	0.92	241.51	222
	Permanent irrigation/well and pump 100 hp	hr	7.60	29.50	224
	In-ground irrigation—storage/holding	hr	5.65	12.00	68
	Above-ground irrigation—storage/holding	hr	11.05	12.00	133
	In-ground irrigation — bed/field	hr	3.13	17.50	55
	Traveler gun	hr	12.06	17.50	211
	Portable PTO pump, 40 hp	hr		(no costs budgeted)	
	Airblast sprayer	hr	1.01	78.75	80
	Seeder	hr	1.05	5.96	6
	Mower	hr	2.98	23.80	71
	Sidedresser, 2-row	hr	0.63	15.70	10
	Cultivator, 2-row	hr	0.95	17.34	16
	Wagon, 4-wheel	hr	0.48	38.34	18
	Truck, 1/2-ton pickup	hr	8.42	520.00	4,378
	Flatbed truck, 24' bed	hr	14.87	716.67	10,657
Subtotal					29,945
Labor					
	Labor hours	hr	6.93‡	6,881.83	47,691
	Related labor hours, 20%	hr	6.93	1,376.00	9,537
Subtotal					57,228
Interest Charge On Operating Capital	Computed at 12% on an annual basis for six months	%	6.0 (0.06)	194,988.00	11,699
Total Variable Costs					206,687
Variable Cost per Salable Plant (1-1/2" Caliper)	Units available for sale in a given year	ea		11,954.00	17.29

*Total nursery = 200 acres, with 175 acres of growing space and 25 acres in production facilities, holding and field bed area, roads, etc. Group V plants = 40 acres, with 35 acres of growing space and 5 acres in production facilities, holding and field bed area, roads, etc., 11,954 1-1/2" salable plants per year.

†Quantity discounts were applied to chemicals and other items.

‡Average basic wage before withholding taxes and fringe benefits = $5.25, taxes and fringe benefits add 32% or $1.68 for a total of $6.93.

**To achieve better pest and disease control, alternative chemical usage is advisable. Alternative chemical costs were estimated at 50% of the cost of Malathion, Benomyl, and Carbaryl.

TABLE 13.—Estimated Variable Costs per Hour of Use for Machinery and Equipment for Field Nurseries, USDA Plant Hardiness Zones 5 and 6, 1985.

Item Number	Item	New Cost ($)	Expected Life (yr.)	Estimated Annual Use: 50 Acre* Nursery (hr.)	Estimated Annual Use: 200 Acre† Nursery (hr.)	Estimated Cost per Hour of Use: Repairs‡ ($)	Fuel** ($)	Lubrication and Filter ($)	Total ($)
1	Tractor, 100 hp	28,278	10	217	494	5 15	10 30	1 55	17 00
2	Tractor, 60 hp	20,419	10	—	583 ea	3.15	7 42	1 11	11 68
3	Tractor, 34 hp	14,504	10	169	632	2.07	2 54	0 38	4 99
4	Flatbed truck	42,000	10	383	1,702	2.22	11 00	1.65	14 87
5	Articulated loader/2,000 lb	25,000	10	—	600	3.75	2 54	0 38	6 67
6	Articulated loader/3,000 lb	38,000	10	328	600	5.70	7 92	1 19	14 81
7	Tree spade	8,490	2	181	641	5.30			5 30
8	Forks for loaders	1,100	10	328	1,200	0.01			0 01
9	Plow	2,616	10	8	32	6.57			6 57
10	Disk	3,900	10	15	60	4.23			4 23
11	Harrow	650	10	2	5	8.45			8 45
12	Cultimulcher	3,800	10	3	10	24.70			24.70
13	Spray rig (boom sprayer)	1,407	7	13	58	2.77			2 77
14	Transplanter, 3-row	7,500	10	5	21	26.79			26 79
15	Transplanter, 1-row	5,000	10	93	407	0.92			0.92
16	Permanent irrigation, well + pump	36,396	20	221	323	0.56	6.12	0.92	7.60
17	In-ground irrigation/bed-field††	34,606	20	151	221	3.13			3.13
18	Above-ground irrigation/bed-field††	4,345	5	144	190	1.83			1.83
19	In-ground irrigation/storage/holding††	16,957	20	60	60	5.65			5.65
20	Above-ground irrigation storage/holding††	8,286	5	60	60	11.05			11 05
21	Traveler gun††	22,000	10	17	73	12.06			12.06
22	Portable irrigation pump (emergency)	425	10	—	—	—	—	—	—
23	Airblast sprayer	3,600	7	94	406	1.01			1.01
24	Fertilizer injector	858	5	9 ea.	9 ea.	12.39			12.39
25	Transplanter, 2-row	5,600	10	8	35	12.00			12.00
26	Undercutter—bed	285	7	5	21	1.16			1.16
27	U-Blade—field	240	5	0.38	1.65	17.65			17.65
28	Fertilizer sidedresser	1,000	10	24	103	0.63			0.63
29	Cultivator, 2-row	1,750	7	44	172	0.95			0.95
30	Wagon	1,978	10	57 ea.	249 ea.	0.48			0.48
31	Cultivator, 3-row	2,250	7	4	15	13.93			13.93
32	Truck—1/2-ton pickup	13,485	5	1,771	2,779	4.37	3.52	0.53	8.42
33	Mower	2,283	10	9	46	2.98			2.98
34	Seeder	175	10	4	10	1.05			1.05

*50 total acres.

†200 total acres.

‡Repairs per hour were based on usage of the large nursery. They were computed on the basis of percent of new cost over the life of the asset. Percent factors used were: 90 for items 1, 2, 3, 4, 5, 6, 32; 80 for items 9, 13, 23; 75 for items 14, 15, 25, 28; 65 for items 10, 11, 12, 24, 29, 31; 60 for items 26, 27, 30, 33, 34; 40 for items 7, 17, 18, 19, 20, 21, 22; and 10 for items 8, 16. The total was then divided by the estimated total number of hours the equipment would be an asset.

**Fuel was estimated at $1.10 per gallon for gasoline-driven items, $1.03 for diesel-driven items, and $0.31 per killowatt for electrical-driven items.

††Cost is for a large nursery on which variable costs per hour were based. Cost for the small nursery was lower.

TABLE 14.—Summary of Fixed, Variable and Total Costs (Dollars) of Operating a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Group I *(Taxus)*	Group II *(Juniperus)*	Group III *(Viburnum)*	Group IV *(Acer rubrum)*	Group V *(Malus)*	Total
Fixed Costs						
Land and improvements	7,061	7,061	7,061	7,061	7,061	35,304†
Buildings	4,740	4,740	4,740	4,740	4,740	23,698†
Machinery and equipment	13,173	13,173	13,173	13,173	13,173	65,866†
General overhead	20,592	20,592	20,592	20,592	20,592	102,960†
Interest on general overhead, insurance and taxes	1,336	1,336	1,336	1,336	1,336	6,678†
Subtotal	46,902	46,902	46,902	46,902	46,902	234,506†
Variable Costs						
Propagation	2,729	1,547	1,634	‡	‡	5,910
Materials	4,067	4,337	4,745	30,949	27,447	71,545
Machinery and equipment	5,894	5,970	5,965	9,897	9,267	36,993
Labor	11,389	12,402	13,735	11,148	13,929	62,603
Interest on operating capital	1.445	1,456	1,565	3,120	3,039	10,625
Subtotal	25,524	25,712	27,644	55,114	53,682	187,676
Total	72,426	72,614	74,546	102,016	100,584	422,182†
Salable Plants Per Year	4,140	5,810	6,208	1,869	2,732	20,759
Cost per Salable Plant	17.49	12.50	12.00	54.58	36.82	20.34

*Total nursery = 50 acres, with 40 acres of growing space and 10 acres in production facilities, holding and field bed area, roads, etc.
†Individual figures do not always add to the total due to rounding.
‡Tree liners were purchased rather than propagated. Liner costs were included under materials.

TABLE 14a.—Summary of Fixed, Variable, and Total Costs (Dollars) of Operating a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Group I *(Taxus)*	Group II *(Juniperus)*	Group III *(Viburnum)*	Group IV *(Acer rubrum)*	Group V *(Malus)*	Total
Fixed Costs						
Land and improvements	21,716	21,716	21,716	21,716	21,716	108,578†
Buildings	6,811	6,811	6,811	6,811	6,811	34,055†
Machinery and equipment	25,495	25,495	25,495	25,495	25,495	127,477†
General overhead	32,685	32,685	32,685	32,685	32,685	163,425†
Interest on general overhead, insurance, and taxes	2,198	2,198	2,198	2,198	2,198	10,990†
Subtotal	88,905	88,905	88,905	88,905	88,905	444,525†
Variable Costs						
Propagation	3,560	2,713	2,814	‡	‡	9,087
Materials	17,070	19,561	20,875	113,506	107,815	278,827
Machinery and equipment	11,739	12,039	14,138	24,747	29,945	92,608
Labor	44,540	52,158	59,590	52,558	57,228	266,074
Interest on operating capital	4,615	5,188	5,845	11,449	11,699	38,796
Subtotal	81,524	91,659	103,262	202,260	206,687	685,392
Total	170,429	180,564	192,167	291,165	295,592	1,129,917†
Salable Plants Per Year	18,156	25,418	27,162	8,177	11,954	90,867
Annual Cost per Salable Plant	9.39	7.10	7.07	35.61	24.73	12.43

*Total nursery = 200 acres, with 175 acres of growing space and 25 acres in production facilities, holding and field bed area, roads, etc.
†Individual figures do not always add to the total due to rounding.
‡Tree liners were purchased rather than propagated. Liner costs were included under materials.

RESULTS AND DISCUSSION

Capital Investment Requirements

Capital investment requirements for establishing field nurseries include land improvements, buildings, and machinery and equipment (Tables 1 and 1a). Each was further divided into several components. The 50-acre nursery required $616,208 in investment. Land and land improvements represented 35% or $215,156 of the investment, buildings 20% or $121,805, and machinery and equipment 45% or $279,247. The 200-acre nursery had an initial investment requirement of $1,379,236. Land and land improvements represented 50% or $684,210 of the investment, buildings 12% or $165,981, and machinery and equipment 38% or $529,045.

The differences in the percentages of total investment between the various components of the two nurseries were primarily caused by the larger nursery being able to make more efficient use of buildings, machinery, and equipment than the smaller nursery. Both nurseries were about equally efficient in the use of growing space.

Land improvement costs, including the pond, in the case of the 50-acre nursery were about 115% of the cost of bare land, but dropped to about 70% of the cost of bare land in the case of the 200-acre nursery. These land improvement costs would be necessary in 'normal' USDA plant hardiness zones 5 and 6 to provide drainage, water storage, and good access to fields in times of inclement weather.

Building needs included a simple office layout, a plant and supply storage building, a machine shop for repairs and storage, polyhouse space for propagation, and polyhouses for overwintering. Details on polyhouse construction are included in Table 3 and those for the irrigation system, including the pump and well, are found in Tables 4-4c.

An important consideration for managers in most industries is determination of investment per unit of production capacity. For field nurseries this indicator would be the capital requirement per-salable-plant capacity. To determine this figure, it was necessary to determine how many salable plants would be produced annually for each group in its allocated 20% of the growing space. This quantity ranged from a low of 1,869 for group IV *(Acer rubrum)* to 6,208 for group III *(Viburnum)* in the 50-acre nursery and from 8,177 to 27,162, respectively, in the 200-acre nursery.

The number of plants grown per unit of space directly

TABLE 15.—Summary of Fixed, Variable and Total Costs (Dollars) per Salable Plant of Operating a 50-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Group I *(Taxus)*		Group II *(Juniperus)*		Group III *(Viburnum)*		Group IV *(Acer rubrum)*		Group V *(Malus)*		Average	
	Cost per Salable Plant	Percent of Total Cost	Cost per Salable Plant	Percent of Total Cost	Cost per Salable Plant	Percent of Total Cost	Cost per Salable Plant	Percent of Total Cost	Cost per Salable Plant	Percent of Total Cost	Cost per Salable Plant	Percent of Total Cost
Fixed Cost Items												
Land and Improvements	1.70	(10)	1.22	(10)	1.14	(9)	3.78	(7)	2.58	(7)	1.70	(8)
Buildings	1.14	(7)	0.82	(7)	0.76	(6)	2.54	(5)	1.73	(5)	1.14	(6)
Machinery and Equipment	3.18	(18)	2.27	(18)	2.12	(18)	7.05	(13)	4.82	(13)	3.17	(16)
General Overhead	4.97	(28)	3.54	(28)	3.32	(28)	11.01	(20)	7.54	(20)	4.96	(24)
Interest on General Overhead, Insurance, and Taxes	0.32	(2)	0.23	(2)	0.22	(2)	0.71	(1)	0.49	(1)	0.32	(1)
Subtotal	11.31	(65)	8.08	(65)	7.56	(63)	25.09	(46)	17.16	(46)	11.29	(55)
Variable Cost Items												
Propagation	0.66	(4)	0.27	(2)	0.26	(3)	†		†		0.29	(1)
Materials	0.98	(5)	0.75	(6)	0.76	(6)	16.56	(30)	10.05	(28)	3.45	(17)
Machinery and Equipment	1.42	(8)	1.03	(8)	0.96	(8)	5.30	(10)	3.39	(9)	1.78	(9)
Labor	2.75	(16)	2.13	(17)	2.21	(18)	5.97	(11)	5.10	(14)	3.02	(15)
Interest on Operating Capital	0.35	(2)	0.25	(2)	0.25	(2)	0.67	(3)	1.11	(3)	0.51	(3)
Subtotal	6.16	(35)	4.43	(35)	4.44	(37)	29.50	(58)	19.65	(54)	9.05	(45)
Total Costs per Salable Plant	17.47	(100)	12.51	(100)	12.00	(100)	54.58	(100)	36.82	(100)	20.34	(100)

*Total nursery = 50 acres, with 40 acres of growing space and 10 acres in production facilities, holding and field bed area, roads, etc.
†Tree liners were purchased rather than propagated. Liner costs were included under materials.

relates to the capital requirements per-salable-plant. These capital costs for the small nursery differentiated by plant group were: $29.77 for group I *(Taxus)*, $21.21 for group II *(Juniperus)*, $19.85 for group III *(Viburnum)*, $65.94 for group IV *(Acer rubrum)*, and $45.11 for group V *(Malus)*. The average for all groups was $29.68. For the 200-acre nursery the respective figures were: $15.19 for group I, $10.85 for group II, $10.16 for group III, $33.73 for group IV, and $23.07 for group V. The average for all groups was $15.18. It required 51% as much investment per-salable-plant capacity in the 200-acre nursery compared to the 50-acre nursery.

Individual nurserymen could, of course, incur somewhat different costs than those presented. Individual costs would depend upon variables such as production cycle chosen, labor productivity, and ability to bargain with suppliers. The nurseryman also may choose not to provide for future expansion, choose land which would require minimum drainage modifications, reduce optimal growing/overwintering space requirements, rent land and/or equipment, and/or operate used equipment. This analysis assumed average soil conditions, expansion capacity, optimal spacing configurations, new buildings, equipment, and machinery.

Production Costs

Fixed

Annual fixed costs associated with capital including depreciation, interest, and taxes were $124,868 per year for the 50-acre nursery. In addition there was $102,960 allocated for general overhead and $6,678 for interest on general overhead, insurance, and taxes. Fixed costs for the 50-acre nursery totaled $234,506 (Table 5). These costs were divided by five and assigned to the respective production areas of the five plant groups, with each group receiving an assessment of $46,902 (Table 14). It was felt that the most reasonable way of assigning annual fixed costs initially is by area. Once the physical facility is provided, fixed costs are incurred at essentially the same amount regardless of how the nursery facility is used.

On a per-salable-plant basis, there was a considerable difference in annual fixed costs among plant groups (Table 15). In the 50-acre nursery, they were: $11.31 for group I *(Taxus)*, $8.08 for group II *(Juniperus)*, $7.56 for group III *(Viburnum)*, $25.09 for group IV *(Acer rubrum)*, and $17.16 for group V *(Malus)*. The average for all groups was $11.29. Fixed costs for group IV

TABLE 15a.—Summary of Fixed, Variable and Total Costs (Dollars) per Salable Plant of Operating a 200-Acre* Field Nursery, USDA Plant Hardiness Zones 5 and 6, 1985.

Item	Group I *(Taxus)*		Group II *(Juniperus)*		Group III *(Viburnum)*		Group IV *(Acer rubrum)*		Group V *(Malus)*		Average	
	Cost per Salable Plant	Percent of Total Cost	Cost per Salable Plant	Percent of Total Cost	Cost per Salable Plant	Percent of Total Cost	Cost per Salable Plant	Percent of Total Cost	Cost per Salable Plant	Percent of Total Cost	Cost per Salable Plant	Percent of Total Cost
Fixed Cost Items												
Land and Improvements	1.20	(13)	0.85	(12)	0.80	(11)	2.66	(7)	1.82	(7)	1.19	(10)
Buildings	0.38	(4)	0.27	(4)	0.25	(4)	0.83	(2)	0.57	(2)	0.37	(3)
Machinery and Equipment	1.40	(15)	1.00	(14)	0.94	(13)	3.11	(9)	2.13	(9)	1.40	(11)
General Overhead	1.80	(19)	1.28	(18)	1.20	(17)	4.00	(11)	2.73	(11)	1.80	(14)
Interest on General Overhead, Insurance, and Taxes	0.12	(1)	0.08	(1)	0.08	(1)	0.27	(1)	0.18	(1)	0.12	(1)
Subtotal	4.90	(52)	3.48	(49)	3.27	(46)	10.87	(30)	7.43	(30)	4.88	(39)
Variable Cost Items												
Propagation	0.20	(2)	0.11	(1)	0.10	(1)	†		†		0.10	(1)
Materials	0.94	(10)	0.77	(11)	0.77	(11)	13.88	(39)	9.02	(37)	3.07	(25)
Machinery and Equipment	0.65	(7)	0.47	(7)	0.52	(8)	3.03	(9)	2.51	(10)	1.02	(8)
Labor	2.45	(26)	2.05	(29)	2.19	(31)	6.43	(18)	4.79	(19)	2.93	(24)
Interest on Operating Capital	0.25	(3)	0.21	(3)	0.22	(3)	1.40	(4)	0.98	(4)	0.43	(3)
Subtotal	4.49	(48)	3.61	(51)	3.80	(54)	24.74	(70)	17.30	(70)	7.55	(61)
Total Costs per Salable Plant	9.39	(100)	7.09	(100)	7.07	(100)	35.61	(100)	24.73	(100)	12.43	(100)

*Total nursery = 200 acres, with 175 acres of growing space and 25 acres in production facilities, holding and field bed area, roads, etc.
†Tree liners were purchased rather than propagated. Liner costs were included under materials.

plants were more than three times as much as for group III. These costs were proportionate to the number of salable plants per annum produced in allocated space. Fixed costs as a percentage of total costs ranged from 46% to 65% in the 50-acre nursery and averaged 55% for the five groups (Table 15).

For the 200-acre nursery, annual fixed costs associated with capital investment (depreciation, interest, insurance, and taxes) were $270,110. An additional $163,425 was allocated for general overhead and $10,990 for interest on general overhead, insurance, and taxes, making a total of $444,525 annual fixed costs for the 200-acre nursery (Table 5a). Assessment per plant group was $88,905 (Table 14a). Fixed costs per-salable-plant were: $4.90 for group I, $3.48 for group II, $3.27 for group III, $10.87 for group IV, and $7.43 for group V and averaged $4.88 for all groups (Table 15a). Fixed costs as a percent of total costs were considerably lower than for the 50-acre nursery, ranging from 30% to 52% and averaged 39% for all groups (Table 15a). This lower percentage was associated with the lower capital requirement per-salable-plant capacity.

Fixed costs per-salable-plant were substantially lower for the 200-acre nursery compared to the 50-acre. For group I the difference was $6.41, for group II $4.60, for group III $4.29, for group IV $14.22, and for group V $9.73 and averaged $6.41 for all groups. This more than doubling in efficiency when going from the 50-acre to the 200-acre nursery is once again attributable to the more efficient use of buildings, machinery, and equipment of the large nursery over the small.

While many nurserymen and others concerned with the industry might feel that the reported fixed cost figures ranging from 30% to 65% of total costs depending upon size of firm and species of plant might be high, these percentages are in line with those for similar industries with new facilities.

Brumfield *et al.* (8), in a synthesized analyses of overhead costs of greenhouse firms, found fixed (overhead) costs as a percent of sales to range from about 45% to more than 67% depending on size of firm and market channel. The values of this study are not directly comparable with Brumfield *et al.* (percent of total costs vs. percent of sales). However, if marketing costs and potential profit were taken into account so that a direct comparison could be made, the fixed costs from the Brumfield study, as a percent of total costs, would be comparable to those reported in these analyses. Recent studies on nurseries, however, showed lower fixed costs as a percentage of total costs.

Badenhop and Phillips (2), for USDA plant hardiness zones 7 and 8, showed fixed costs ranging from 37% to 48% of total costs in a 50-acre nursery and from 27% to 36% in a 100-acre nursery. Most of the difference between the two studies could be accounted for by differences in budgeting. Badenhop and Phillips did not provide for irrigation or drainage, two very expensive procedures provided for in this study. They also allocated less for nursery overhead. Finally, they used different procedures for computing interest on investment. In computing interest on depreciable items, the calculations by Badenhop and Phillips were based on one-half the original value of depreciable items to reflect the recovery of those items through depreciation. In this study, interest was computed on the total cost of depreciable items. The procedures used by Badenhop and Phillips would reduce costs below those reported here.

Taylor, *et al.*, (14) in a study of container operations in USDA plant hardiness zone 6, found fixed (overhead) costs as a percent of total costs to range from 37% to 51% depending on size of firm and number of salable plants. Analytical procedures in the Taylor, *et al.* study were identical to this study. The major difference in that study vs. this study is in the number of salable plants produced per year. In the container study, a nursery containing approximately 8 acres of growing space would produce about 95,650 salable plants per year, and a nursery containing approximately 16 acres of growing space would produce about 192,095 salable plants per year. Therefore, fixed (overhead) costs were distributed over many more plants. Also, capital requirements per salable plant capacity were much lower in the container nurseries. For the 8-acre (growing space) nursery, they ranged from $4.63 to $9.09 per capital requirement per-salable-plant capacity. In the 16-acre (growing space) nursery, they ranged from $3.71 to $7.39. As reported earlier, capital requirements per salable plant in this study ranged from $10.16 to $65.94 depending upon species of plant and size of field nursery.

One of the major reasons for the large difference in capital requirements per salable plant capacity lies in the plant rotations. The container nursery operated on a 2-year rotation while the rotations for this field study range from 4 years in the case of group III *(Viburnum)* and group V plants *(Malus)* to 7 years in the case of group I *(Taxus)* plants.

Nurserymen having established facilities might well consider annual fixed costs to be lower than those reported here. This is especially true if they calculate depreciation and repairs on the original value of land improvements, buildings, machinery, and equipment and if they place a low value on their own management input. Good management for planning purposes, however, dictates computing depreciation and repairs on the current value of facilities and equipment rather than on original cost. It also dictates placing a value on managerial time that would be comparable to salaries paid in competitive firms.

Variable

Variable costs differentiated by size of firm and plant group are detailed in Tables 8-12a. There were substantial differences between plant groups, but little difference by size of nursery.

Total variable costs for the 50-acre nursery for the small nursery by plant group were $25,524 for group I *(Taxus),* $25,712 for group II *(Juniperus),* $27,644 for group III *(Viburnum),* $55,114 for group IV *(Acer rubrum),* and $53,682 for group V *(Malus).* Total for all groups was $187,676 (Table 14). The difference in total variable costs between groups is primarily accounted for

by the cost of producing liners and in labor for harvesting. Liners for trees were purchased and were much more expensive than liners for shrubs which were propagated on site. Also, trees require much more labor to harvest per unit than is the case for the shrub groups. On a per-salable-plant basis, variable costs were $6.16 for group I, $4.43 for group II, $4.44 for group III, $29.50 for group IV, and $19.65 for group V and averaged $9.05 for all groups. Variable costs for the small nursery ranged from 35% to 58% of total costs and averaged 45% for all groups (Table 15).

For the 200-acre nursery, variable costs by plant group were $81,524 for group I, $91,659 for group II, $103,262 for group III, $202,260 for group IV, and $206,687 for group V. Total for all groups was $685,392 (Table 14a). On a per-salable-plant basis, they were $4.49 for group I, $3.61 for group II, $3.80 for group III, $24.74 for group IV, $17.30 for group V, and averaged $7.55 for all groups (Table 15a). Variable costs for the large nursery ranged from 48% to 70% of total costs and averaged 61% for all groups.

The difference in variable costs between sizes of nurseries was less pronounced than in the case of fixed costs. The difference for group I was $1.67, for group II $0.82, for group III $0.64, for group IV $4.76, and for group V $2.35, and averaged $1.50 for all groups.

Total

Total costs are the summation of fixed and variable costs. For the 50-acre nursery they were $72,426 for group I *(Taxus),* $72,614 for group II *(Juniperus),* $74,546 for group III *(Viburnum),* $102,016 for group IV *(Acer rubrum),* and $100,584 for group V *(Malus).* For all groups they totaled $422,182 (Table 14). On a per-salable-plant basis, they were $17.47 for group I, $12.51 for group II, $12.00 for group III, $54.58 for group IV, and $36.82 for group V, and averaged $20.34 for all groups (Table 15).

Total costs for the 200-acre nursery were $170,429 for group I, $180,564 for group II, $192,167 for group III, $291,165 for group IV, and $295,592 for group V. They totaled $1,129,917 for all groups (Table 14a). On a per-salable-plant basis, they were $9.39 for group I, $7.09 for group II, $7.07 for group III, $35.61 for group IV, and $24.73 for group V, and averaged $12.43 for all groups (Table 15a).

Differences in total costs per salable plant between the two sizes of nurseries were $8.08 for group I, $5.42 for group II, $4.93 for group III, $18.97 for group IV, and $12.09 for group V, and averaged $7.91 for all groups. Note that of the total differential, most was caused by differences in fixed costs. Overall, it was 39% less expensive to produce plants in the 200-acre nursery compared to the 50-acre ($12.43 per plant in the 200-acre nursery vs. $20.34 in the 50-acre). For fixed costs, the differential was 57% ($4.88 in the 200-acre nursery vs. $11.29 in the 50-acre), while for variable costs there was only a 17% advantage ($7.55 in the 200-acre nursery vs. $9.05 in the 50-acre). This means that fixed costs accounted for more than 77% and variable costs less than 23% of the cost differentials per-salable-plant between the two sizes of nurseries. For nurseries of the sizes analyzed, economies of size are achieved primarily in fixed rather than variable costs. Variable costs presented should be quite representative for zones 5 and 6 nurseries doing a good job of management.

One note of caution should be observed in comparing costs between the two sizes of nurseries. Each of the nurseries was analyzed based on the assumption that they would produce a diverse line of plants which included both shrubs and trees. This assumption might be unrealistic for the 50-acre nursery as a considerable amount of specialized equipment was required. It should also be noted that many operators of smaller nurseries might choose a different line of equipment than that budgeted. While the equipment budgeted is capable and labor saving, smaller nurserymen might have a surplus of family labor and choose less expensive, less labor-saving equipment. Also, a small nursery might well operate its office, etc. out of the home.

SUMMARY AND IMPLICATIONS

Large-size commercial field nurseries use buildings, equipment, and machinery more efficiently than small-size field nurseries. As a result, large nurseries have a lower cost per salable plant.

Total costs per salable plant in the 50-acre nursery differentiated by species ranged from $12.00 to $54.58 and averaged $20.34 for all species. In the large nursery, comparable values were $7.07 to $35.61 and averaged $12.43 for all species. More than 77% of the differential noted between the two sizes of nurseries can be attributed to differences in fixed costs.

Fixed costs per salable plant in the 50-acre nursery ranged from $7.56 to $25.09 and averaged $11.29. In the 200-acre nursery, comparable costs were $3.27 to $10.87 and averaged $4.88. The greater than 100% gain in efficiency when going from the 50-acre to 200-acre nursery is attributable to more efficient use of buildings, machinery, and equipment. Fixed costs as a percentage of total costs in the 50-acre nursery ranged from 46% to 65% and averaged 55% for all species. Comparable values for the 200-acre nursery were 30% to 52% and averaged 39%. Differences in fixed costs among plant groups resulted from a combination of space requirements and the number of years a plant would be in rotation.

Variable costs per salable plant showed differences among plant species and were also affected by size of nursery. In the 50-acre nursery, they ranged from $4.43 to $29.50 and averaged $9.05 across species. Comparable figures for the 200-acre nursery were $3.61 to $24.74 and averaged $7.55. Major differences among species affecting variable costs were spacing requirements, cost of liners, and labor for harvesting. Variable costs as a percentage of total costs in the 50-acre nursery ranged from 35% to 58% and averaged 45%. Comparable values for the 200-acre nursery were 48% to 70% and averaged 61%.

These figures demonstrated that variable costs per salable plant, while having wide variations among species, remain reasonably constant when comparisons are made between the two sizes of nurseries. The 50-acre nursery could purchase materials and other variable items almost as cheaply as could the 200-acre nursery. Fixed costs on a per-salable-plant basis, in contrast, changed significantly as size of nursery increased. This occurred because most of the fixed factors required to operate the 50-acre nursery such as management, buildings, and most machinery and equipment were also adequate to operate the 200-acre nursery. As the size of nursery increased, costs for fixed items of production were spread over more salable units, thereby reducing the fixed cost per salable plant.

Implications

A comparison of total costs of producing "B & B" plants in a 50-acre nursery in the field in USDA plant hardiness zones 5 and 6 with prices in producers' wholesale catalogs would undoubtedly show selling prices lower than total annual costs. In fact, a comparison of costs with prices for the 200-acre field nursery would also, at best, show marginal returns. In fact, if one were to add costs of selling, very few producers would presently be charging enough to cover all costs, let alone profits. How then can producers continue to operate? The answer lies in how producers both experience and compute costs. The authors have used the economic and accounting method which includes both explicit and implicit costs. Explicit costs are those which are paid directly and easily determined; for example, cost of liners, soil media, polyethylene, chemicals, and labor. Implicit costs are those which are more difficult to determine, such as the cost of equity capital and implied managerial salaries. The way these costs are determined varies significantly from firm to firm. Well-established nurseries are usually very accurate in determining explicit costs, but often do not consider all implicit costs. They base their costs on "cash flow" and profit and loss on "tax accounting." These established nurseries may have purchased land at low cost, be working with depreciated equipment, and may be assigning low if any value to their management; in this case determined costs would be at a much lower level than presented in this paper. Also, as pointed out earlier, careful site selection could significantly reduce fixed (overhead) costs. However, if one were to start a new field nursery, producing a wide range of plant materials, in a "normal" USDA plant hardiness zone 5 or 6 site, costs would probably be very close to those presented here.

For the industry, selling nursery products below "accounting costs" implies that well-established nurseries, operating essentially debt free, would have strong staying power whereas those which have just started or are heavily in debt may not be able to survive, especially if they are relying on their field operation to meet all overhead expenses. Second, starting a field nursery (unless it was quite large) in USDA plant hardiness zones 5 and 6 would probably not prove profitable unless items like buildings, equipment, machinery, and management could be shared with other enterprises or unless selling prices of nursery products in the zones increased substantially. At current prices for nursery products, this study shows that the return on investment for establishing new, independently operating, field nurseries in USDA plant hardiness zones 5 and 6 would be marginal if not negative.

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APPENDIX A
PROPAGATION PRODUCTION CYCLES

Slow-Growing Evergreens (Taxus)

November-December of First Production Year

1. **Collecting Cuttings.** Collect cuttings from field plants which are at least 3 years old. Cuttings should measure at least 7 inches. Cuttings are collected at a rate of 1,400 per hour.
2. **Preparing Cuttings.** Strip lower needles off lower 4 inches of cuttings and dip into IBA powder #8. Cuttings are prepared at a rate of 1,000 per hour.
3. **Sticking Cuttings.** Stick treated cuttings into a bottom heated sand bed in overwinter house. Sticking is accomplished at a rate of 1,200 per hour.
4. **Irrigation.** Using an automatic mist system, keep watered until rooted and then reduce watering.

January-December of Second Production Year

1. **Irrigation.** Keep cuttings moist.
2. **Fertilization.** Liquid feed every 2 weeks between April and August.

March of Third Production Year

1. **Harvest.** Pull rooted cuttings from propagation beds and prune prior to transplanting into field beds.

Fast-Growing Evergreens (Juniperus)

November-December of First Production Year

1. **Collecting Cuttings.** Collect cuttings from plants at least 3 years old. Cuttings should measure at least 7 inches. Cuttings are collected at rate of 600 per hour.
2. **Preparing Cuttings.** Strip lower leaves off lower 3 inches and dip into IBA powder #3. Cuttings can be prepared at a rate of 500 per hour.
3. **Sticking Cuttings.** Stick treated cuttings into a bottom heated sand bed in overwinter house. Cuttings can be stuck at a rate of 1,000 per hour.
4. **Irrigation.** Using an automatic mist system, keep watered until rooted and then reduce watering.

March of Second Production Year

1. **Harvest.** Pull rooted cuttings from propagation beds for pruning before transplanting into field beds. Harvesting is accomplished at a rate of 500 cuttings per hour.

Deciduous Shrubs (Viburnum)

June of First Production Year

1. **Collect Cuttings.** Collect cuttings from field plants at least 2 years old. Cuttings are collected at a rate of 1,000 per hour.
2. **Preparing Cuttings.** Strip off the lower leaves and dip into IBA powder #1. Cuttings are prepared at a rate of 1,000 per hour.
3. **Sticking Cuttings.** Treated cuttings are stuck into a bottom heated sand bed in an overwinter house. They are stuck at a rate of 1,000 per hour.
4. **Irrigation.** Using an automatic mist system, cuttings are kept watered until rooted. After rooting, reduce irrigation.

July of First Production Year-March of Second Production Year

1. **Maintenance of Plants.** Standard irrigation and feeding.

March of Second Production Year

1. **Harvesting.** Pull rooted cuttings from propagation beds prior to transplanting into field beds. Cuttings are harvested at a rate of 400 per hour.

APPENDIX B
Taxus LINER AND FIELD PRODUCTION CYCLES (7-YEAR CYCLE)
(Taxus is representative of slow-growing evergreens)

Liner Production

April of First Production Year

1. **Land Preparation Prior to Planting Bed Liners.** The bed area for growing rooted cuttings is prepared by plowing land with a three-bottom plow. One ton of lime and 1,130 lb of blended fertilizer (200 lb of 45-0-0, 430 lb of 0-44-0, 500 lb of 0-0-60) per acre are custom applied by a local fertilizer distributor. The land is further worked, twice with a disk and then harrowed. Just prior to planting, fields are cultimulched to help incorporate a preemergence herbicide (Trifluralin 4EC at 1 qt per acre) into the top 2 to 3 inches of soil. The herbicide is sprayed onto the soil using a spray rig and 10-foot boom attached to the tractor pulling the cultimulcher.

May of First Production Year

1. **Liner Preparation.** Liners (18 months old) are root pruned by hand prior to planting.
2. **Planting of Liners.** Pruned liners are transported to the bed area in a flatbed truck. They are then transplanted into beds 4 feet wide, using a three-row mechanical transplanter. The rooted cuttings are spaced 20 inches apart between rows and 7 inches within rows. Using a crew of nine, approximately 5,000 rooted cuttings can be planted per hour.

General Maintenance

1. **Irrigation.** Irrigation of rooted cuttings is of primary concern the first year during root system development. Portable aluminum 4-inch pipe is set up and shifted within the first year's bed area to supplement natural rainfall. Plants are irrigated 20 times during the summer and fall at the rate of 1 inch of water per irrigation.
2. **Fertilization.** Nutrients (200 lb of soluble 20-20-20 fertilizer/acre/application) are injected three times into the irrigation water to help stimulate plant growth.
3. **Weed Control.** Weed control is effected by a combination of six mechanical cultivations, three hand weedings, and two applications of herbicides. The spring herbicide program consists of spraying the area with 1.0 lb aia of Simazine 80WP plus 5.25 lb aia of DCPA 75WP. The fall herbicide program involves spraying the beds with 2.0 lb aia of Simazine 80WP.
4. **Pest Control.** Pest control is obtained through the use of insecticides (24 oz of Malathion 57EL and 1.25 lb of Carbaryl 80WP per acre) and fungicides (0.5 lb Benomyl 50WP per acre). They are sprayed onto the plants three times a growing season, utilizing an airblast sprayer pulled by a tractor.
5. **Pruning.** Where necessary, bed plants are lightly pruned of any straying branches.

May-September of Second and Third Production Years

1. **Plant Maintenance.** The same cultural practices which occurred in the first growing season, May-September, are repeated for the second and third growing seasons.

April of Fourth Production Year

1. **Harvesting of Bed Liners.** The 3-year bed liners are dug using a 50-inch undercutter with lift tines. The liners are separated from each other and bundled in lots of 25. The bundles are loaded onto pallets which have been placed on a flatbed truck. The truck is then driven into the storage building where the pallets are unloaded using a four-wheel drive articulated loader.

May-September of Fourth Production Year

1. **Land Preservation.** After the bed liners are harvested, the land is left fallow until the next spring planting season. Weeds are kept down through disking the bed area four times during the third growing season. Ideally, a cover crop (sudan, for example) would be grown for one or two seasons to restore organic matter and to reduce soil compaction.

Production in the Field

April of First Field Production Year

1. **Land Preparation.** Prior to transplanting the bed liners into the field, the land would be plowed. After plowing, 3 tons of lime and 1,130 lb of blended fertilizer (200 lb of 45-0-0, 430 lb of 0-44-0, 500 lb of 0-0-60) per acre are custom applied by a local fertilizer distributor. The lime and fertilizer are disked in and the ground is later harrowed. Just prior to planting, fields are cultimulched to help incorporate a pre-emergence herbicide (Trifluralin 4EC at 1 qt per acre) and to break up clods of soil which could clog a mechanical transplanter.
2. **Liner Preparation.** The 3-year-old bed liners are root and top pruned by hand prior to planting to help initiate new roots and compact branching.
3. **Planting of Liners.** Pruned liners are transported to the field area on a flatbed truck and mechanically transplanted at a rate of 5,065 plants per acre with 44 inches between rows and 28 inches between plants. Using a two-row transplanter pulled by a 100 HP tractor, an eight-man crew can plant approximately 2,400 liners per hour.
4. **Irrigation.** Two irrigations are used to help set the liners.

May-September of First Field Production Year

1. **Weed Control.** Two applications of herbicides, two mechanical cultivations, four mowings, and two hand weedings are required. Early season (1.0 lb aia Simazine, 5.25 lb aia DCPA) and late season (2.0 lb aia Simazine) herbicides are applied using a spray rig with a 10-foot boom mounted upon a 34 HP tractor. The late season herbicide is applied after the last cultivation. Mechanical cultivation (two-row cultivator attached to a 34 HP tractor) is utilized within rows to help eradicate weeds. Hand hoeing is then accomplished to reach weeds not eradicated by cultivators.
2. **Fertilizer Program.** Supplemental nitrogen, 220 lb of urea (45-0-0) per acre, is side dressed in early fall for increased plant growth.
3. **Pest Control.** Pest control is obtained through the use of insecticides (24 oz of Malathion 57EL and 1.25 lb of Carbaryl 80WP per acre) and fungicides (0.5 lb of Benomyl 50WP per acre). They are sprayed onto the plants three times a growing season, utilizing an airblast sprayer pulled by a tractor.
4. **Pruning.** Tips of branches are pruned with hedge shears to induce branching.

May-September of Second Through Sixth Field Production Years

1. **Plant Maintenance.** Plant maintenance during these 5 years is identical to the first season except for an additional application of nitrogen fertilizer,

220 lb of urea (45-0-0) per acre, side dressed each spring.

September of Sixth Field Production Year

1. **Harvesting.** One-fourth (25%) of the salable crop is selected and tagged for digging (small nursery 1,035 plants, large nursery 4,539 plants). Seven plants per labor hour are balled and burlapped, carried out of the field, and loaded onto pallets on a flatbed truck parked at the side of the field. The palletized plants are transported to the shipping area, unloaded, and organized according to customer order.
2. **Shipping.** All plants harvested are loaded onto a semitruck. A crew of four, with an articulated four-wheel drive loader, can load 690 plants (truck capacity) in 2 hours.

October-December of Sixth Field Production Year

1. **Harvesting and Overwintering.** An additional 25% of the total salable stock is dug for early spring sales and overwintered in polyhouses (small nursery 1,035 plants, large nursery 4,534 plants). Pallets of dug material are unloaded and the material is spaced within the polyhouse framework (2 feet on centers with a 2-foot aisle way).
2. **Irrigation.** The permanent irrigation system is used an estimated five times to supply additional moisture to supplement natural rainfall.
3. **Covering of Polyhouses.** Polyhouses are covered as late as possible with 4-mil white polyfilm which acts as a barrier to drying winds, extremes in temperature, and humidity loss.
4. **Fungus Control.** Covered polyhouses are fumigated with a fumigant bomb (3-10M cu ft Exothermic Termil bombs per polyhouse) to control storage molds and fungi.

January-March of Seventh Field Production Year

1. **Inspection of Fall Dug Materials.** Fall dug plants are checked for any possible winter damage.
2. **Fungus Control.** A second set of fumigant bombs is set off to further control molds and fungi.
3. **Shipping of Fall Dug Material.** Shipments of overwintered plants start in late February with stock being loaded onto pallets, hauled to the shipping area, and loaded onto trucks. Approximately 18.5% of the total salable crop is shipped (small nursery 766 plants, large nursery 3,359 plants).
4. **Harvesting.** One-fifth (20%) of the total salable crop is harvested (small nursery 828 plants, large nursery 3,531 plants).

April of Seventh Field Production Year

1. **Inspection and Shipping of Remaining Fall Dug Material.** Any remaining overwintered stock is shipped. Care is exercised to avoid mixing overwintered and spring harvested plants.
2. **Harvesting.** The remaining 30% of the total salable crop is harvested and hauled into the shipping area (small nursery 1,242 plants, large nursery 5,446 plants).
3. **Irrigation.** Plants are irrigated using a portable irrigation system combined with the inground system to help supplement natural rainfall, especially during sunny and windy days.
4. **Shipping.** Approximately 38% of the total salable crop is shipped (small nursery 1,573 plants, large nursery 6,899 plants).

May of Seventh Field Production Year

1. **Irrigation.** Five irrigations are supplied to remaining salable plants to maintain quality.
2. **Shipping.** The remaining 18.5% of salable plants are pulled from the holding area, transported on pallets to the shipping area, arranged according to customer order, loaded, and shipped (small nursery 766 plants, large nursery 3,359 plants).
3. **Shifting of Irrigation Equipment.** Portable irrigation pipe is taken down and used in the summer irrigation system of the bed liners.

Summer and Fall of Seventh Field Production Year

1. **Land Preservation.** After the last plants are harvested, the empty fields are left fallow. Fallow fields are disked for weed control four times during summer months.
2. **Land Preparation.** Fields are plowed in the fall in preparation for spring planting.

APPENDIX C
Juniperus LINER AND FIELD PRODUCTION CYCLES (5-YEAR CYCLE)
(*Juniperus* is representative of rapid growing evergreens)

Liner Production

April of First Production Year

1. **Land Preparation Prior to Planting Bed Liners.** The bed area for growing rooted cuttings is prepared by plowing land with a three-bottom plow. One ton of lime and 1,130 lb of blended fertilizer (200 lb of 45-0-0, 430 lb of 0-44-0, 500 lb of 0-0-60) per acre are custom applied by a local fertilizer distributor. The land is further worked, twice with a disk and then harrowed. Just prior to planting, fields are cultimulched to help incorporate a preemergence herbicide (Trifluralin 4EC at 1 qt per

acre) into the top 2 to 3 inches of soil. The herbicide is sprayed onto the soil using a spray rig and 10-foot boom attached to the tractor pulling the cultimulcher.

May of First Production Year

1. **Liner Preparation.** Liners (6 months old) are root pruned by hand prior to planting.
2. **Planting of Liners.** Pruned liners are transported to the bed area in a flatbed truck. They are then transplanted into beds 4 feet wide, using a three-row mechanical transplanter. The rooted cuttings are spaced 20 inches apart between rows and 7 inches within rows. Using a crew of nine, approximately 5,000 rooted cuttings can be planted per hour.

General Maintenance

1. **Irrigation.** Irrigation of rooted cuttings is of primary concern the first year during root system development. Portable aluminum 4-inch pipe is set up and shifted within the first year's bed area to supplement natural rainfall. Plants are irrigated 20 times during the summer and fall at the rate of 1 inch of water per irrigation.
2. **Fertilization.** Nutrients (200 lb of soluble 20-20-20 fertilizer/acre/application) are injected three times into the irrigation water to help stimulate plant growth.
3. **Weed Control.** Weed control is effected by a combination of six mechanical cultivations, three hand weedings, and two applications of herbicides. The spring herbicide program consists of spraying the area with 1.0 lb aia of Simazine 80WP plus 5.25 lb aia of DCPA 75 WP. The fall herbicide program involves spraying the beds with 2.0 lb aia of Simazine 80WP.
4. **Pest Control.** Pest control is obtained through the use of insecticides (24 oz of Malathion 57EL and 1.25 lb of Carbaryl 80WP per acre) and fungicides (0.5 lb Benomyl 50WP per acre). They are sprayed onto the plants three times a growing season, utilizing an airblast sprayer pulled by a tractor.
5. **Pruning.** Where necessary, bed plants are lightly pruned of any straying branches.

May-September of Second Production Year

1. **Plant Maintenance.** The same cultural practices which occurred in the first growing season, May-September, are repeated for the second growing season.

April of Third Production Year

1. **Harvesting of Bed Liners.** The 2-year bed liners are dug using a 50-inch undercutter with lift tines. The liners are separated from each other and bundled in lots of 25. The bundles are loaded onto pallets which have been placed on a flatbed truck. The truck is then driven into the storage building where the pallets are unloaded using a four-wheel drive articulated loader.

May-September of Third Production Year

1. **Land Preservation.** After the bed liners are harvested, the land is left fallow until the next spring planting season. Weeds are kept down through disking the bed area four times during the second growing season. Ideally, a cover crop (sudan, for example) would be grown for one or two seasons to restore organic matter and to reduce soil compaction.

Production in the Field

April of First Field Production Year

1. **Land Preparation.** Land would be plowed in the fall prior to transplanting bed liners into the field. Before transplanting, 3 tons of lime and 1,130 lb of blended fertilizer (200 lb of 45-0-0, 430 lb of 0-44-0, 500 lb of 0-0-60) per acre are custom applied by a local fertilizer distributor. The lime and fertilizer are disked in and the ground is later harrowed. Just prior to planting, fields are cultimulched to help incorporate a pre-emergence herbicide (Trifluralin 4EC at 1 qt per acre) and to break up clods of soil which could clog a mechanical transplanter.
2. **Liner Preparation.** The 2-year-old bed liners are root and top pruned by hand prior to planting to help initiate new roots and compact branching.
3. **Planting of Liners.** Pruned liners are transported to the field area on a flatbed truck and mechanically transplanted at a rate of 5,065 plants per acre, with 44 inches between rows and 28 inches between plants. Using a two-row transplanter pulled by a 100 HP tractor, an eight-man crew can plant approximately 2,400 liners per hour.
4. **Irrigation.** Two irrigations are used to help set the liners.

May-September of First Field Production Year

1. **Weed Control.** Two applications of herbicides, two mechanical cultivations, four mowings, and two hand weedings are required. Early season (1.0 lb aia Simazine, 5.25 lb aia DCPA) and late season (2.0 lb aia Simazine) herbicides are applied using a spray rig with a 10-foot boom mounted upon a 34 HP tractor. The late season herbicide is applied after the last cultivation. Mechanical cultivation (two-row cultivator attached to a 34 HP tractor) is utilized within rows to help eradicate weeds. Hand hoeing is then accomplished to reach weeds not eradicated by cultivators.
2. **Fertilizer Program.** Supplemental nitrogen, 220 lb of urea (45-0-0 per acre), is side dressed in early fall for increased plant growth.
3. **Pest Control.** Pest control is obtained through the use of insecticides (24 oz of Malathion 57EL and 1.25 lb of Carbaryl 80WP per acre) and fungicides

(0.5 lb of Benomyl 50WP per acre). They are sprayed onto the plants three times a growing season, utilizing an airblast sprayer pulled by a tractor.

4. **Pruning.** Tips of branches are pruned with hedge shears to induce branching.

May-September of Second, Third, and Fourth Field Production Years

1. **Plant Maintenance.** Plant maintenance during these 3 years is identical to the first season except for an additional application of nitrogen fertilizer, 220 lb of urea (45-0-0 per acre), side dressed each spring.

September of Fourth Field Production Year

1. **Harvesting.** One-fourth (25%) of the salable crop is selected and tagged for digging (small nursery 1,452 plants, large nursery 6,355 plants). Seven plants per labor hour are balled and burlapped, carried out of the field, and loaded onto pallets on a flatbed truck parked at the side of the field. The palletized plants are transported to the shipping area, unloaded, and organized according to customer order.
2. **Shipping.** All plants harvested are loaded onto a semitruck. A crew of four, with an articulated four-wheel drive loader, can load 690 plants (truck capacity) in 2 hours.

October-December of Fourth Field Production Year

1. **Harvesting and Overwintering.** An additional 25% of the total salable stock is dug for early spring sales and overwintered in polyhouses (small nursery 1,452 plants, large nursery 6,355 plants). Pallets of dug material are unloaded and the material is spaced within the polyhouse framework (2 feet on centers with a 2-foot aisle way).
2. **Irrigation.** The permanent irrigation system is used an estimated five times to supply additional moisture to supplement natural rainfall.
3. **Covering of Polyhouses.** Polyhouses are covered as late as possible with 4-mil white polyfilm which acts as a barrier to drying winds, extremes in temperature, and humidity loss.
4. **Fungus Control.** Covered polyhouses are fumigated with a fumigant bomb (3-10M cu ft Exothermic Termil bombs per polyhouse) to control storage molds and fungi.

January-March of Fifth Field Production Year

1. **Inspection of Fall Dug Materials.** Fall dug plants are checked for any possible winter damage.
2. **Fungus Control.** A second set of fumigant bombs is set off to further control molds and fungi.
3. **Shipping of Fall Dug Material.** Shipments of overwintered plants start in late February with stock being loaded onto pallets, hauled to the shipping area, and loaded onto trucks. Approximately 18.5% of the total salable crop is shipped (small nursery 1,075 plants, large nursery 4,702 plants.
4. **Harvesting.** One-fifth (20%) of the total salable crop is harvested (small nursery 1,162 plants, large nursery 5,084 plants).

April of Fifth Field Production Year

1. **Inspection and Shipping of Remaining Fall Dug Material.** Any remaining overwintered stock is shipped. Care is exercised to avoid mixing overwintered and spring harvested plants.
2. **Harvesting.** The remaining 30% of the total salable crop is harvested and hauled into the shipping area (small nursery 1,743 plants, large nursery 7,625 plants).
3. **Irrigation.** Plants are irrigated using a portable irrigation system combined with the inground system to help supplement natural rainfall, especially during sunny and windy days.
4. **Shipping.** Approximately 38% of the total salable crop is shipped (small nursery 2,208 plants, large nursery 9,659 plants).

May of Fifth Field Production Year

1. **Irrigation.** Five irrigations are supplied to remaining salable plants to maintain quality.
2. **Shipping.** The remaining 18.5% of salable plants are pulled from the holding area, transported on pallets to the shipping area, arranged according to customer order, loaded, and shipped.
3. **Shifting of Irrigation Equipment.** Portable irrigation pipe is taken down and used in the summer irrigation system of the bed liners.

Summer and Fall of Fifth Field Production Year

1. **Land Preservation.** After the last plants are harvested, the empty fields are left fallow. Fallow fields are disked for weed control four times during summer months.
2. **Land Preparation.** Fields are plowed in the fall in preparation for spring planting.

APPENDIX D
Viburnum LINER AND FIELD PRODUCTION CYCLES (4-YEAR CYCLE)
(Viburnum is representative of deciduous shrubs)
Liner Production

April of First Production Year

1. **Land Preparation Prior to Planting Bed Liners.** The bed area for growing rooted cuttings is prepared by plowing land with a three-bottom plow. One ton of lime and 1,130 lb of blended fertilizer (200 lb of 45-0-0, 430 lb of 0-44-0, 500 lb of 0-0-60) per acre are custom applied by a local fertilizer distributor. The land is further worked, twice with a disk and then harrowed. Just prior to planting, fields are cultimulched to help incorporate a pre-emergence herbicide (Trifluralin 4EC at 1 qt per acre) into the top 2 to 3 inches of soil. The herbicide is sprayed onto the soil using a spray rig and 10-foot boom attached to the tractor pulling the cultimulcher.

May of First Production Year

1. **Liner Preparation.** Liners (9 months old) are root pruned by hand prior to planting.
2. **Planting of Liners.** Pruned liners are transported to the bed area in a flatbed truck. They are then transplanted into beds 4 feet wide, using a three-row mechanical transplanter. The rooted cuttings are spaced 20 inches apart between rows and 7 inches within rows. Using a crew of nine, approximately 5,000 rooted cuttings can be planted per hour.

General Maintenance

1. **Irrigation.** Irrigation of rooted cuttings is of primary concern the first year during root system development. Portable aluminum 4-inch pipe is set up and shifted within the first year's bed area to supplement natural rainfall. Plants are irrigated 20 times during the summer and fall at the rate of 1 inch of water per irrigation.
2. **Fertilization.** Nutrients (200 lb of soluble 20-20-20 fertilizer/acre/application) are injected three times into the irrigation water to help stimulate plant growth.
3. **Weed Control.** Weed control is effected by a combination of six mechanical cultivations, three hand weedings, and two applications of herbicides. The spring herbicide program consists of spraying the area with 1.0 lb aia of Simazine 80WP plus 5.25 lb aia of DCPA 75WP. The fall herbicide program involves spraying the beds with 2.0 lb aia of Simazine 80WP.
4. **Pest Control.** Pest control is obtained through the use of insecticides (24 oz of Malathion 57EL and 1.25 lb of Carbaryl 80WP per acre) and fungicides (0.5 lb Benomyl 50WP per acre). They are sprayed onto the plants three times a growing season, utilizing an airblast sprayer pulled by a tractor.
5. **Pruning.** Where necessary, bed plants are lightly pruned of any straying branches.

April of Second Production Year

1. **Harvesting of Bed Liners.** The 2-year bed liners are dug using a 50-inch undercutter with lift tines. The liners are separated from each other and bundled in lots of 25. The bundles are loaded onto pallets which have been placed on a flatbed truck. The truck is then driven into the storage building where the pallets are unloaded using a four-wheel drive articulated loader.

May-September of Second Production Year

1. **Land Preservation.** After the bed liners are harvested, the land is left fallow until the next spring planting season. Weeds are kept down through disking the bed area four times during the second growing season. Ideally, a cover crop (sudan, for example) would be grown for one or two seasons to restore organic matter and to reduce soil compaction.

Production in the Field

April of First Field Production Year

1. **Land Preparation.** Land would be plowed in the fall prior to transplanting bed liners into the field. Before transplanting, 3 tons of lime and 1,130 lb of blended fertilizer (200 lb of 45-0-0, 430 lb of 0-44-0, 500 lb of 0-0-60) per acre are custom applied by a local fertilizer distributor. The lime and fertilizer are disked in and the ground is later harrowed. Just prior to planting, fields are cultimulched to help incorporate a pre-emergence herbicide (Trifluralin 4EC at 1 qt per acre) and to break up clods of soil which could clog a mechanical transplanter.
2. **Liner Preparation.** The 2-year-old bed liners are root and top pruned by hand prior to planting to help initiate new roots and compact branching.
3. **Planting of Liners.** Pruned liners are transported to the field area on a flatbed truck and mechanically transplanted at a rate of 4,356 plants per acre, with 48 inches between rows and 30 inches between plants. Using a two-row transplanter pulled by a 100 HP tractor, an eight-man crew can plant approximately 2,400 liners per hour.
4. **Irrigation.** Two irrigations are used to help set the liners.

May-September of First Field Production Year

1. **Weed Control.** Two applications of herbicides, two mechanical cultivations, four mowings, and two hand weedings are required. Early season (1.0 lb aia Simazine, 5.25 lb aia DCPA) and late season

(2.0 lb aia Simazine) herbicides are applied using a spray rig with a 10-foot boom mounted upon a 34 HP tractor. The late season herbicide is applied after the last cultivation. Mechanical cultivation (two-row cultivator attached to a 34 HP tractor) is utilized within rows to help eradicate weeds growing in spite of herbicides. Hand hoeing is then accomplished to reach weeds not eradicated by cultivators.

2. **Fertilizer Program.** Supplemental nitrogen, 220 lb of urea (45-0-0 per acre), is side dressed in early fall for increased plant growth.
3. **Pest Control.** Pest control is obtained through the use of insecticides (24 oz of Malathion 57EL and 1.25 lb of Carbaryl 80WP per acre) and fungicides (0.5 lb of Benomyl 50WP per acre). They are sprayed onto the plants three times a growing season, utilizing an airblast sprayer pulled by a tractor.
4. **Pruning.** Tips of branches are pruned with hedge shears to induce branching.

April-September of Second Field Production Year

1. **Pruning.** Plants are pruned to ground level to induce multiple stem plants.
2. **Plant Maintenance.** Plant maintenance is identical to the first season except for an additional application of nitrogen fertilizer (220 lb of urea, 45-0-0 per acre) side dressed each spring.

April-August of Third Field Production Year

1. **Pruning.** Plants are lightly tip-pruned to maintain uniformity and promote secondary branching.
2. **Plant Maintenance.** Plant maintenance is identical to the second field production year, including side dressing nitrogen fertilizer.

September of Third Field Production Year

1. **Harvesting.** One-fourth (25%) of the salable crop is selected and tagged for digging (small nursery 1,552 plants, large nursery 6,791 plants). Six plants per labor hour are balled and burlapped, carried out of the field, and loaded onto pallets on a flatbed truck parked at the side of the field. The palletized plants are transported to the shipping area, unloaded, and organized according to customer order.
2. **Shipping.** All plants harvested are loaded onto a semitruck. A crew of four, with an articulated four-wheel drive loader, can load 690 plants (truck capacity) in 2 hours.

October-December of Third Field Production Year

1. **Harvesting and Overwintering.** An additional 25% of the total salable stock is dug for early spring sales and overwintered in polyhouses (small nursery 1,552 plants, large nursery 6,791 plants). Pallets of dug material are unloaded and the material is spaced within the polyhouse framework (2 feet on centers with a 2-foot aisle way).
2. **Irrigation.** The permanent irrigation system is used an estimated five times to supply additional moisture to supplement natural rainfall.
3. **Covering of Polyhouses.** Polyhouses are covered as late as possible with 4-mil white polyfilm which acts as a barrier to drying winds, extremes in temperature, and humidity loss.
4. **Fungus Control.** Covered polyhouses are fumigated with a fumigant bomb (3-10M cu ft Exothermic Termil bombs per polyhouse) to control storage molds and fungi.

January-March of Fourth Field Production Year

1. **Inspection of Fall Dug Materials.** Fall dug plants are checked for any possible winter damage.
2. **Fungus Control.** A second set of fumigant bombs is set off to further control molds and fungi.
3. **Shipping of Fall Dug Material.** Shipments of overwintered plants start in late February with stock being loaded onto pallets, hauled to the shipping area, and loaded onto trucks. Approximately 18.5% of the total salable crop is shipped (small nursery 1,148 plants; large nursery 5,025 plants).
4. **Harvesting.** One-fifth (20%) of the total salable crop is harvested.

April of Fourth Field Production Year

1. **Inspection and Shipping of Remaining Fall Dug Material.** Any remaining overwintered stock is shipped. Care is exercised to avoid mixing overwintered and spring harvested plants.
2. **Harvesting.** The remaining 30% of the total salable crop is harvested and hauled into the shipping area (small nursery 1,862 plants, large nursery 8,149 plants).
3. **Irrigation.** Plants are irrigated using a portable irrigation system combined with the inground system to help supplement natural rainfall, especially during sunny and windy days.
4. **Shipping.** Approximately 38% of the total salable crop is shipped (small nursery 2,359 plants, large nursery 10,322 plants).

May of Fourth Field Production Year

1. **Irrigation.** Five irrigations are supplied to remaining salable plants to maintain quality.
2. **Shipping.** The remaining 18.5% of salable plants are pulled from the holding area, transported on pallets to the shipping area, arranged according to customer order, loaded, and shipped (small nursery 1,148 plants, large nursery 5,025 plants).
3. **Shifting of Irrigation Equipment.** Portable irrigation pipe is taken down and used in the summer irrigation system of the bed liners.

Summer and Fall of Fourth Field Production Year

1. **Land Preservation.** After the last plants are harvested, the empty fields are left fallow. Fallow fields are disked for weed control four times during summer months.
2. **Land Preparation.** Fields are plowed in the fall in preparation for spring planting.

APPENDIX E
Acer rubrum FIELD PRODUCTION CYCLES (5-YEAR CYCLE) (Acer rubrum is representative of shade trees)

January-March of First Production Year

1. **Liner Preparation.** Two-year liners are root and top pruned by hand prior to planting to help initiate new roots and compact branching.

April of First Production Year

1. **Land Preparation Prior to Planting.** Three tons of lime and 1,130 lb of blended fertilizer (200 lb of 45-0-0, 430 lb of 0-44-0, 500 lb of 0-0-60) per acre are custom applied by a local fertilizer distributor. The lime and fertilizer are "disked-in" to land which was plowed the previous fall. After disking, the ground is harrowed. Just prior to planting, fields are cultimulched to help incorporate a preemergence herbicide (Trifluralin 4EC at 1 qt per acre) and to break up clods of soil which could clog a mechanical transplanter.
2. **Planting of Liners.** Pruned liners are transported to the field area on a flatbed truck and hand transplanted at a rate of 1,361 plants per acre, with 96 inches between rows and 42 inches between plants. Using a one-row transplanter pulled by a 100 HP tractor, an 18-man crew can prune, haul, plant, and straighten approximately 1,000 liners per hour.
3. **Irrigation.** Two irrigations would be used to help set the liners.

May-September of First Production Year

1. **Weed Control.** Two applications of herbicides, two mechanical cultivations, four mowings, and two hand weedings are required. Early season herbicides (1.0 lb aia Simazine, 5.25 lb aia DCPA) are band applied. Late season, a herbicide (2.0 lb aia Simazine) is applied after the last cultivation, using a spray rig with a 7-foot boom mounted on a 34 HP tractor. The area between rows is planted with grass (Kentucky 31), leaving a 2-foot clear band for cultivation and herbicide maintenance. This allows for good soil maintenance, minimum erosion, and early access for digging. Mechanical cultivation (one-row cultivator attached to a 34 HP tractor) is utilized within the rows to help eradicate weeds growing in spite of herbicides. Hand hoeing is then accomplished to reach weeds not eradicated by cultivators. Grass is mowed four times throughout the year.
2. **Fertilizer Program.** Supplemental nitrogen, 220 lb of urea (45-0-0 per acre), is side dressed in early fall for increased plant growth.
3. **Pest Control.** Pest control is obtained through the use of insecticides (24 oz of Malathion 57EL and 1.25 lb of Carbaryl 80WP per acre) and fungicides (0.5 lb Benomyl 50WP per acre). They are sprayed onto the plants three times a growing season, utilizing an airblast sprayer pulled by a tractor.
4. **Pruning.** Tips of branches are pruned with hand shears to induce branching.

May-September of Second, Third, and Fourth Production Years

1. **Plant Maintenance.** Maintenance is identical to the first year.

October of Fourth Production Year

1. **Harvesting.** One-fourth (25%) of the salable crop is selected and tagged for digging (small nursery 467 plants, large nursery 2,044 plants). A digging crew of seven mechanically digs and transports 16.8 (2.4 per man hour) plants per hour to pallets on a wagon parked at the side of the field. A second crew transports and unloads the palletized plants into the shipping area according to customer orders.
2. **Shipping.** All plants harvested are loaded onto a semitruck. A crew of four with an articulated four-wheel drive loader, can load 100 plants (truck capacity) in 2-½ hours.

November-December of Fourth Production Year

1. **Harvesting and Overwintering.** An additional 25% of the total salable stock is dug for early spring sales (small nursery 467 plants, large nursery 2,044 plants). Pallets of dug material are unloaded and spaced in rows by variety and size. Overwintering includes "heeling-in" the plants in wood chips.
2. **Irrigation.** The permanent irrigation system, in conjunction with above ground pipe, is used an estimated five times to supply moisture to supplement natural rainfall.
3. **Rabbit Control.** Trunks are sprayed with rabbit repellent.

January-March of Fifth Production Year

1. **Inspection of Fall Dug Materials.** Fall dug plants are checked for winter damage (mice, rabbits, sunscald).

2. **Rabbit Control.** A second application of rabbit repellent is sprayed on tree trunks.
3. **Shipping of Fall Dug Material.** Shipments of overwintered plants start in late February, with stock being loaded onto pallets, hauled to the shipping area, and loaded onto trucks. Approximately 18.5% of the total salable crop is shipped (small nursery 346 plants, large nursery 1,513 plants).
4. **Harvesting.** One-fifth (20%) of the total salable crop is harvested (small nursery 363 plants, large nursery 1,635 plants).

April of Fifth Production Year

1. **Inspection and Shipping of Remaining Fall Dug Material.** Any remaining overwintered stock is shipped. Care is exercised to avoid mixing overwintered and spring harvested plants.
2. **Harvesting.** The remaining 30% of the total salable crop is harvested and hauled into the shipping or holding area prior to "leaf-out" in the field (small nursery 561 plants, large nursery 2,453 plants).
3. **Irrigation.** Plants are irrigated using a portable irrigation system combined with the inground system to help supplement natural rainfall, especially during sunny and windy days.
4. **Shipping.** Approximately 38% of the total salable crop is shipped (small nursery 710 plants, large nursery 3,107 plants).

May of Fifth Production Year

1. **Irrigation.** Five irrigations are supplied to remaining salable plants to maintain quality.
2. **Shipping.** The remaining 18.5% of salable plants are pulled from the holding area, transported on pallets to the shipping area, loaded, and shipped (small nursery 346 plants, large nursery 1,513 plants).
3. **Shifting of Irrigation Equipment.** Portable irrigation pipe is taken down and used in the summer irrigation system of the bed liners.

Summer and Fall of Fifth Production Year

1. **Land Preservation.** After the last plants are harvested, the empty fields are left fallow. Fallow fields are disked for weed control four times during summer months.
2. **Land Preparation.** Fields are plowed in the fall in preparation for spring planting.

APPENDIX F
Malus FIELD PRODUCTION CYCLES (4-YEAR CYCLE) (Malus is representative of ornamental trees)

January-March of First Production Year

1. **Liner Preparation.** Two-year liners are root and top pruned by hand prior to planting to help initiate new roots and compact branching.

April of First Production Year

1. **Land Preparation Prior to Planting.** Three tons of lime and 1,130 lb of blended fertilizer (200 lb of 45-0-0, 430 lb of 0-44-0, 500 lb of 0-0-60) per acre are custom applied by a local fertilizer distributor. The lime and fertilizer are "disked-in" to land which was plowed the previous fall. After disking, the ground is harrowed. Just prior to planting, fields are cultimulched to help incorporate a preemergence herbicide (Trifluralin 4EC at 1 qt per acre) and to break up clods of soil which could clog a mechanical transplanter.
2. **Planting of Liners.** Pruned liners are transported to the field area on a flatbed truck and hand transplanted at a rate of 1,815 plants per acre, with 96 inches between rows and 36 inches between plants. Using a one-row transplanter pulled by a 100 HP tractor, an 18-man crew can prune, haul, plant, and straighten approximately 1,000 liners per hour.
3. **Irrigation.** Two irrigations would be used to help set the liners.

May-September of First Production Year

1. **Weed Control.** Two applications of herbicides, two mechanical cultivations, four mowings, and two hand weedings are required. Early season herbicides (1.0 lb aia Simazine, 5.25 lb aia DCPA) are band applied. Late season, a herbicide (2.0 lb aia Simazine) is applied after the last cultivation, using a spray rig with a 7-foot boom mounted on a 34 HP tractor. The area between rows is planted with grass (Kentucky 31), leaving a 2-foot clear band for cultivation and herbicide maintenance. This allows for good soil maintenance, minimum erosion, and early access for digging. Mechanical cultivation (one-row cultivator attached to a 34 HP tractor) is utilized within the rows to help eradicate weeds. Hand hoeing is then accomplished to reach weeds not eradicated by cultivators. Grass is mowed four times throughout the year.
2. **Fertilizer Program.** Supplemental nitrogen, 220 lb of urea (45-0-0 per acre), is side dressed in early fall for increased plant growth.
3. **Pest Control.** Pest control is obtained through the use of insecticides (24 oz of Malathion 57EL and 1.25 lb of Carbaryl 80WP per acre) and fungicides (0.5 lb Benomyl 50WP per acre). They are sprayed

onto the plants three times per growing season, utilizing an airblast sprayer pulled by a tractor.

4. **Pruning.** Tips of branches are pruned with hand shears to induce branching.

February-April of Second and Third Production Years

1. **Pruning.** Corrective pruning is carried out to induce better branching.

May-September of Second and Third Production Years

1. **Plant Maintenance.** Maintenance is identical to the first year.

October of Third Production Year

1. **Harvesting.** One-fourth (25%) of the salable crop is selected and tagged for digging (small nursery 683 plants, large nursery 2,989 plants). A digging crew of seven mechanically digs and transports 16.8 plants per hour (2.4 per man hour) to pallets on a wagon parked at the side of the field. A second crew transports and unloads the palletized plants into the shipping area according to customer orders.
2. **Shipping.** All plants harvested are loaded onto a semitruck. A crew of four with an articulated four-wheel drive loader can load 140 plants (truck capacity) in 2-½ hours.

November-December of Third Production Year

1. **Harvesting and Overwintering.** An additional 25% of the total salable stock is dug for early spring sales (small nursery 683 plants, large nursery 2,989 plants). Pallets of dug material are unloaded and spaced in rows by variety and size. Overwintering includes "heeling-in" the plants in wood chips.
2. **Irrigation.** The permanent irrigation system, in conjunction with above ground pipe, is used an estimated five times to supply moisture to supplement natural rainfall.
3. **Rabbit Control.** Trunks are sprayed with rabbit repellent.

January-March of Fourth Production Year

1. **Inspection of Fall Dug Materials.** Fall dug plants are checked for winter damage (mice, rabbits, sunscald).
2. **Rabbit Control.** A second application of rabbit repellent is sprayed on tree trunks.
3. **Shipping of Fall Dug Material.** Shipments of overwintered plants start in late February, with stock being loaded onto pallets, hauled to the shipping area, and loaded onto trucks. Approximately 18.5% of the total salable crop is shipped (small nursery 505 plants, large nursery 2,211 plants).
4. **Harvesting.** One-fifth (20%) of the total salable crop is harvested (small nursery 546 plants, large nursery 2,391 plants).

April of Fourth Production Year

1. **Inspection and Shipping of Remaining Fall Dug Material.** Any remaining overwintered stock is shipped. Care is exercised to avoid mixing overwintered and spring harvested plants.
2. **Harvesting.** The remaining 30% of the total salable crop is harvested and hauled into the shipping or holding area prior to "leaf-out" in the field (small nursery 820 plants, large nursery 3,586 plants).
3. **Irrigation.** Plants are irrigated using a portable irrigation system combined with the inground system to help supplement natural rainfall, especially during sunny and windy days.
4. **Shipping.** Approximately 38% of the total salable crop is shipped (small nursery 1,038 plants, large nursery 4,543 plants).

May of Fourth Production Year

1. **Irrigation.** Five irrigations are applied to remaining salable plants to maintain quality.
2. **Shipping.** The remaining 18.5% of salable plants are pulled from the holding area, transported on pallets to the shipping area, loaded, and shipped (small nursery 505 plants, large nursery 2,211 plants).
3. **Shifting of Irrigation Equipment.** Portable irrigation pipe is taken down and used in the summer irrigation system of the bed liners.

Summer and Fall of Fourth Production Year

1. **Land Preservation.** After the last plants are harvested, the empty fields are left fallow. Fallow fields are disked for weed control four times during summer months.
2. **Land Preparation.** Fields are plowed in the fall in preparation for spring planting.

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